

# IRP Proposed 25-26 CAISO TPP Portfolios and Initial Busbar Mapping Results

Workshop

Energy Division Staff  
November 5, 2024



California Public  
Utilities Commission

# Introduction

# Scope

- Proposed 25-26 TPP Portfolios Sept. 12th, 2024, Ruling comments were received Sept. 30, and reply comments were received by Oct. 10.
  - IRP staff are still in process of incorporating stakeholder feedback into the mapping efforts.
- Workshop focuses on an overview of the proposed base case and sensitivity portfolios for the 25-26 TPP and preliminary busbar mapping results, noting that the mapping process is still ongoing and further changes will occur.
- The objectives of this workshop are to:
  - Provide an overview of the proposed 25-26 TPP base case and sensitivity portfolios.
    - Including small modelling updates used in their development.
  - Re-familiarize stakeholders with busbar mapping process and criteria.
    - Recap on the criteria and changes incorporated since the 24-25 TPP mapping.
    - Overview of environmental and land-use analysis implemented in busbar mapping.
  - Preview preliminary mapping results of the base case.
    - Provide a summary of busbar mapping results for the proposed base case portfolio and a discussion of the busbar mapping analysis.
    - Provide overview of identified mapping issues and next mapping steps.

# Logistics

- Workshop slides, updated busbar mapping dashboard, and supporting material are available on the IRP webpage: [Assumptions for the 2025-2026 TPP](#).

**Questions:** We invite clarifying questions using the "Q&A" feature of this Webex.

- We also invite verbal questions at specific intervals throughout this workshop.
  - All attendees have been muted. To ask questions:
    - In Webex:
      - Please “raise your hand”
      - Webex host will unmute your microphone and you can proceed to ask your question
      - Please “lower your hand” afterwards
    - For those with phone access only:
      - Dial \*3 to “raise your hand”. Once you have raised your hand, you'll hear the prompt, "You have raised your hand to ask a question. Please wait to speak until the host calls on you“
      - WebEx host will unmute your microphone and you can proceed to ask your question
      - Dial \*3 to “lower your hand”
- Comments to the Oct. 30th Ruling for the initial mapping and this workshop are due by November 19, 2024

# Agenda

Time	Topic	Presenter
9:00 AM	Introduction & IRP background	Nathan Barcic
9:10 AM	TPP & Busbar Mapping overview	Jared Ferguson
9:20 AM	Proposed 25-26 TPP portfolios & modeling results	Sarah Goldmuntz Sierra Spencer
9:50 AM	Busbar Mapping Methodology overview	Jared Ferguson
10:20 AM	CEC: Land-use and environmental analysis in busbar mapping	Saffia Hossainzadeh
11:00 AM	Overview of preliminary mapping results	Jared Ferguson
11:45 AM	Questions & Wrap Up	-

# IRP Background

# CPUC & Integrated Resource Planning

- CPUC established the **Integrated Resource Planning** process for setting electricity resource planning targets for CPUC-Jurisdictional LSEs in CAISO's BAA.
  - Consistent with SB 350 (2015) and SB 100 (2018).
  - Designed as a multi-step analytical planning process with input from load-serving entities and stakeholders.
- IRP intends to achieve a resource portfolio that achieves:
  - Reliability
  - Greenhouse Gas Emission (GHG) reductions and clean energy procurement
  - Least cost
- Most recently adopted IRP “Preferred System Plan”, which plans for a portfolio that could reduce GHGs by 58% in 2035 compared to 2020 levels.

CA-wide GHG Emissions Planning Target

million metric tons



**Source:** CPUC February 2024 Preferred System Plan Portfolio, <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/long-term-procurement-planning/2022-irp-cycle-events-and-materials>

# Overview of the 2024-26 IRP Cycle

Year 1

Year 2

Year 3 & Beyond

## Abbreviation key

- Load Serving Entity (LSE)
- Preferred System Plan (PSP)
- Transmission Planning Process (TPP)

Updates to Inputs & Assumptions

1. LSE Plan Filing Requirements

2. LSE Plan Development & Review

3. CPUC Creates Preferred System Plan

4. Procurement and Policy Implementation

25-26 TPP Decision

TPP Decision

PSP/TPP Decision

Portfolio(s) transmitted to CAISO for TPP

Portfolio(s) transmitted to CAISO for TPP

Portfolio(s) transmitted to CAISO for TPP

**We are here**

# TPP and Busbar Mapping Overview

# Overview of the CAISO's Transmission Planning Process

- Every year Commission staff develop a recommended set of portfolios for the California Independent System Operator (CAISO) to use in its annual Transmission Planning Process (TPP).
- Generally, in each TPP cycle, the CAISO evaluates a reliability and/or policy-driven base case portfolio.
  - Under the CAISO tariff adopted by the Federal Energy Regulatory Commission (FERC), if the results of the base case analysis show the need for additional transmission development, the transmission projects are brought to the CAISO Board for approval in the spring of the second year of the TPP.
  - If approved by the CAISO Board, under the FERC tariff, a transmission project would receive cost recovery through the transmission access charge.
- Along with the base case analysis that generally leads directly to transmission project approval, in each TPP cycle the CAISO typically analyzes one or more sensitivity portfolios.
  - The purpose of the sensitivity portfolio analysis is not to lead directly to transmission development immediately, but rather to assist in future planning by identifying relevant transmission needs and potential costs.
- The Commission adopted the 2024-25 TPP portfolio in Decision (D.)24-02-047. This Decision included both a base case and a sensitivity portfolio that the CAISO is in the process of analyzing for the current TPP cycle.
  - The base case portfolio was based on the scenario that achieves a 25 million metric ton (MMT) greenhouse gas (GHG) emissions target in 2035, including 4.5 gigawatts (GW) of offshore wind.
  - The sensitivity portfolio was a High Natural Gas Retirement scenario, designed to assist in planning for the potential future retirement of fossil-fueled resources as their economics decline.

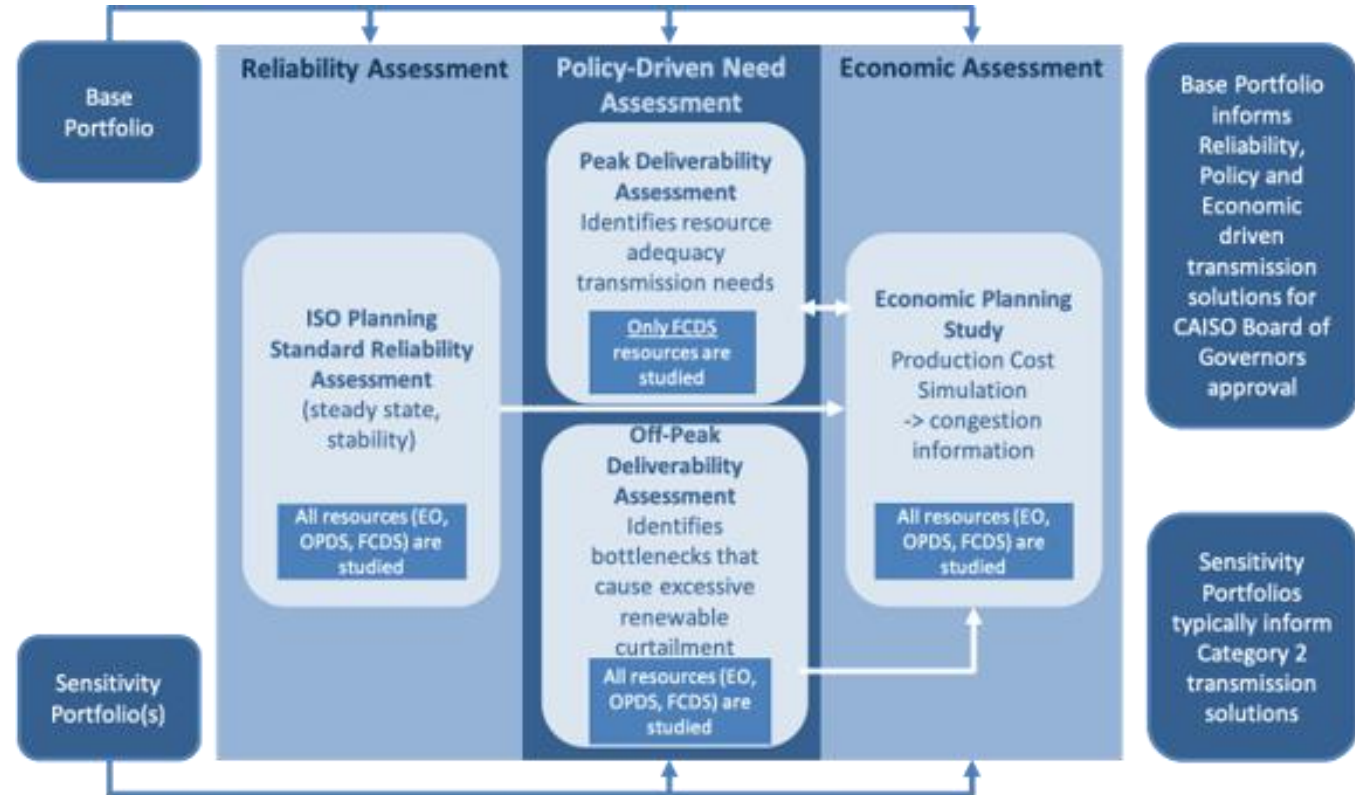
# IRP's Role in the CAISO's Transmission Planning Process (1 of 2)

- The CAISO's TPP is an annual comprehensive evaluation of the CAISO's transmission grid to:

1. Address grid reliability requirements,
2. Identify projects needed to successfully meet California's policy goals, and
3. Explore projects that can bring economic benefits to consumers.

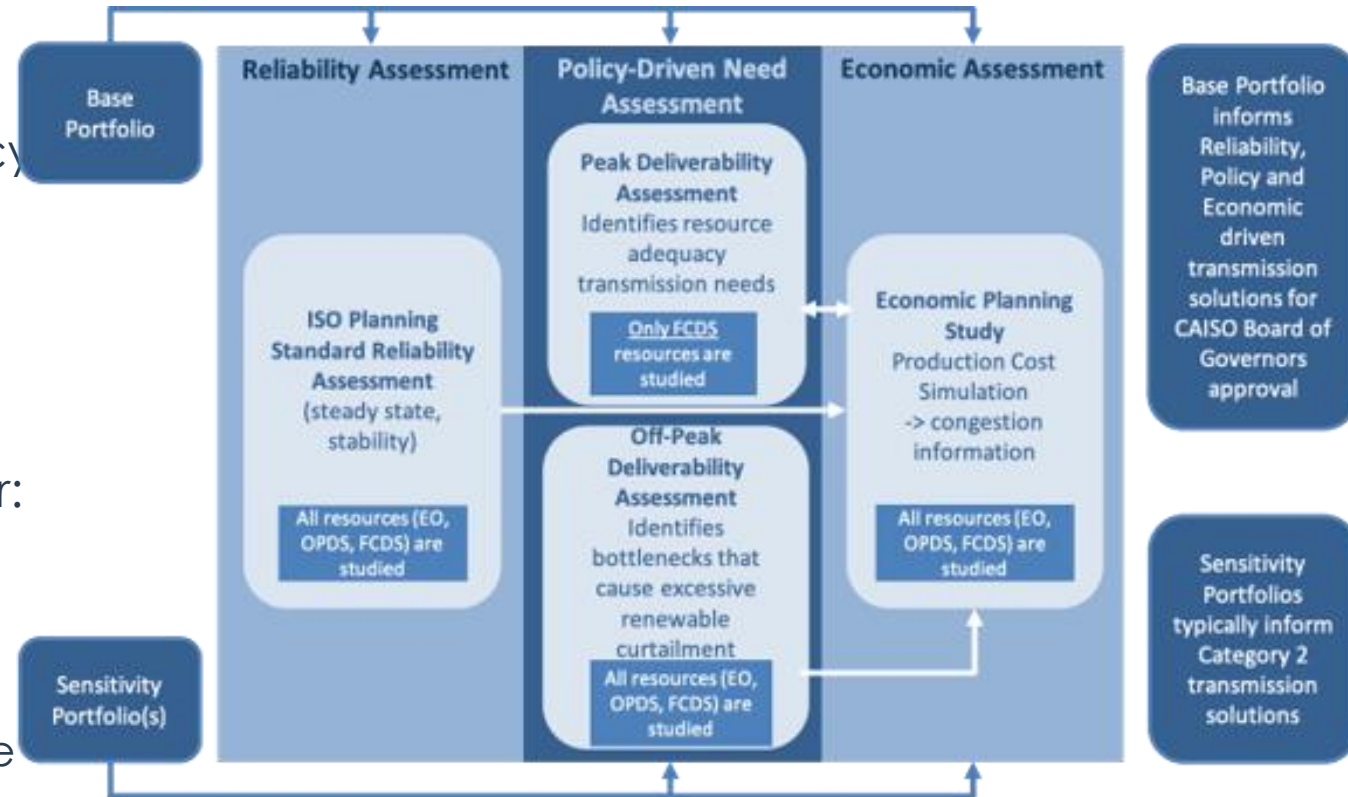
- CPUC develops resource portfolios and CEC develops load scenarios for use by CAISO in the TPP.

- In accordance with new CPUC-CEC-CAISO [Memorandum of Understanding](#) agreed to in Dec. 2022.
- Replaced and expanded on the May 2010 MOU between the CAISO and the CPUC.



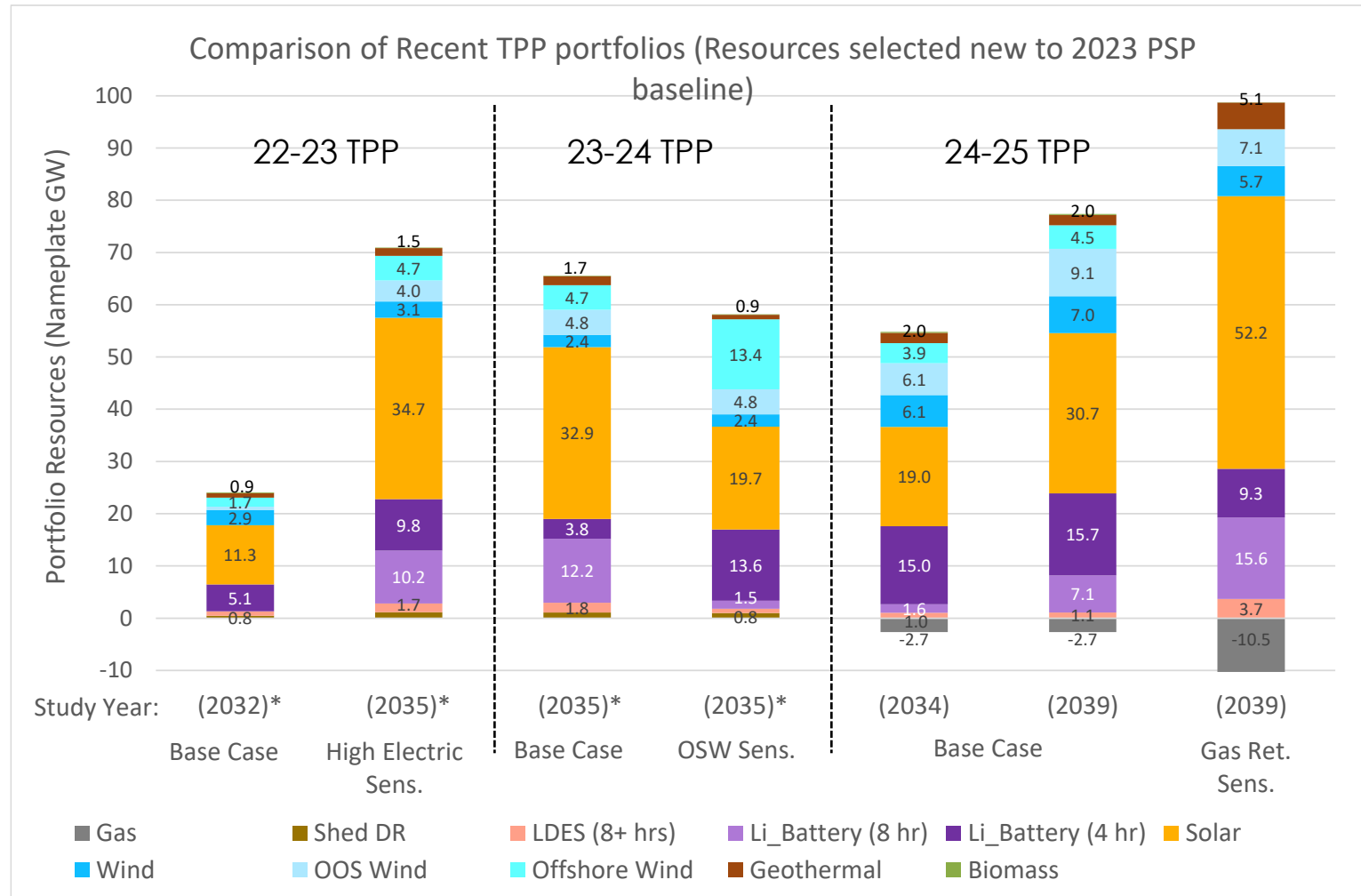
# IRP's Role in the CAISO's Transmission Planning Process (2 of 2)

- The CPUC typically transmits multiple distinct portfolios developed in the IRP process:
  - Reliability and Policy-Driven Base Case portfolio
  - Policy-Driven Sensitivity portfolio(s)
- Base Cases are designed to reflect CPUC policy guidance, including reliability and GHG reduction targets, and provide regulatory certainty for transmission planning
  - Lead to identified transmission solutions going to the CAISO Board of governors for approval.
- Policy-Driven Sensitivities are designed to either:
  - Support a “least regrets” approach that provides a reasonable range of future scenarios that can be linked to the base case, or
  - Gather additional transmission information to support future portfolio development and explore incremental optionality or risk.
  - Identified transmission solutions do not directly go to the CAISO board for approval, but can help inform base case solutions.



# Recent TPP Portfolios Transmitted to CAISO

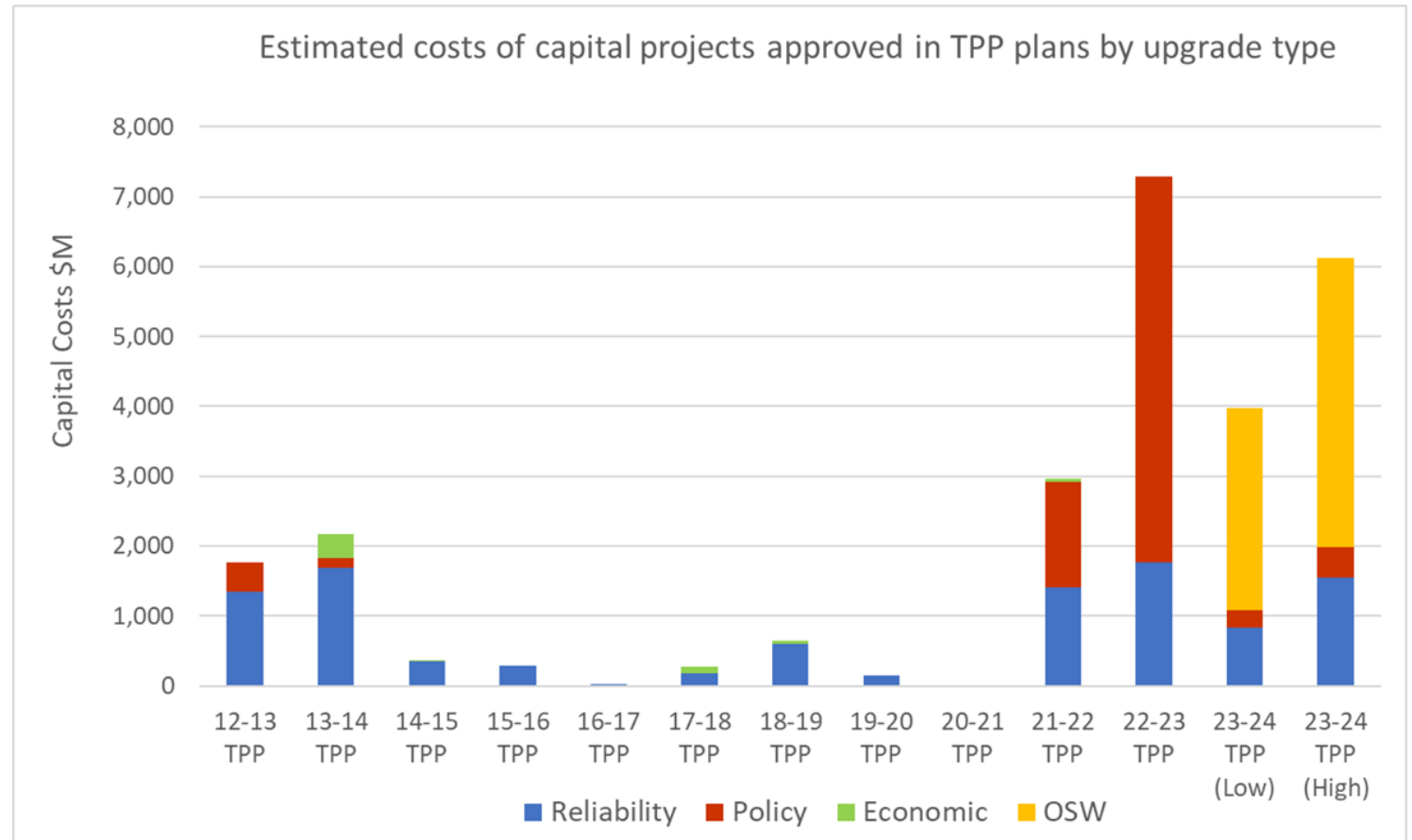
- Historically has focused on grid needs up to 10-years into the future.
- Shifted to transmitting portfolios that model further out into the future:
  - Per Public Utilities Code § 454.57 (SB 887, 2022), portfolios passed to the CAISO will model out at least 15 years.
  - The 24-25 TPP, transmitted this February, included mapped results for 2034 (10-years out) and 2039 (15-years out).
- For the past few TPP cycles, the CPUC has mapped and transmitted a base case and one sensitivity portfolio.



\* Resource amounts in graph adjusted to account for updated baseline used for 24-25 TPP portfolios. The 23-24 TPP and earlier portfolio modeled Li Battery durations aggregated. These have been separated to 4- and 8 hr for comparison to 24-25 TPP portfolios.

# Recent TPP Results

- The Annual TPP includes summary of transmission projects approved by the CAISO Board
- These projects, depending on size, cost, and location, are then either
  - Constructed by the incumbent transmission operator, or
  - Go out for competitive solicitation, through CAISO's process to select entity to build project
- Chart on right depicts approved transmission projects for each TPP study by cost estimated in that year's TPP report and project type.



Upgrades Approved in TPP		20-21 TPP	21-22 TPP	22-23 TPP	23-24 TPP
Reliability Driven Upgrades	No. of Upgrades	3	16	24	19
	Est. Cost (\$billions)	\$ 0.02 – 0.04	\$ 0.9 – 1.4	\$ 1.69	\$0.8 – 1.5
Policy Driven Upgrades	No. of Upgrades	None	7	21	7
	Est. Cost (\$billions)	0	\$1.2 – 1.6	\$ 5.2	\$3.1 – 4.6

# Role of Busbar Mapping in IRP and TPP

- **Resource to Busbar Mapping** (“busbar mapping”): The process of refining the geographically coarse portfolios developed through IRP to specific interconnection locations (i.e., substations) for analysis in the CAISO’s annual Transmission Planning Process (TPP).
  - Joint effort by a working group comprised of CPUC, CEC, and CAISO staff.
  - Mapping focuses on utility-scale generation and storage resources that are not already in baseline.
  - First conducted as “proof of concept” for the 2018-2019 TPP portfolio ([CEC proof of concept report](#)).
  - Guided by the stakeholder-vetted mapping methodology, a document that states guiding principles, establishes mapping criteria, and outlines the iterative inter-agency mapping process.
    - Current [Mapping Methodology for the 25-26 TPP](#).

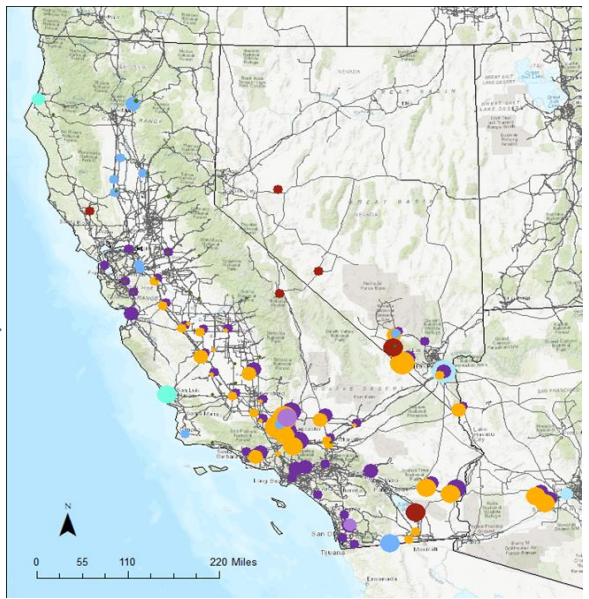
**Input: Portfolio developed from LSE plans & RESOLVE model results**

Resource Type	MW by 2032
Biomass	134
Geothermal	1,160
Wind	3,531
Wind OOS New Tx	1,500
Offshore Wind	1,708
Utility-Scale Solar	17,506
Battery Storage	13,571
Long-duration Storage	1,000
Shed Demand Response	441
<b>Total</b>	<b>40,551</b>

RESOLVE Resource Name	2032 Total (MW)
Greater_LA_Solar	1
Northern_California_Solar	-
Southern_PGAE_Solar	1,238
Tehachapi_Solar	2,969
Greater_Kramer_Solar	3,166
Southern_NV_Eldorado_Solar	7,382
Riverside_Solar	4,001
Arizona_Solar	-
Imperial_Solar	-



**Output: Substation-level location for resources**



# Overview of the Proposed 25-26 TPP Portfolio analysis

# Overview of 25-26 TPP Analysis

- Staff has conducted analysis to support the development of portfolios for consideration for study in CAISO's 25-26 TPP.
  - The analysis is based on the 24-25 TPP portfolio that the Commission adopted in [D.24-02-047](#).
- On September 15, the Commission issued an Administrative Law Judge [Ruling Seeking Comment on Electricity Resource Portfolios for 2025-2026 Transmission Planning Process](#). That Ruling, and the accompanying [slide deck](#), included two TPP portfolio classifications:
  - A proposed 25-26 TPP Base Case .
  - Two options for a 25-26 TPP sensitivity cases, including ED Staff's recommended portfolio.
    - Today's workshop will cover only ED Staff's recommended sensitivity portfolio.

# 25-26 TPP Timeline

- Transmission Planning Portfolio (TPP) Ruling issued on September 12, 2024, describing the TPP analysis and seeking comment on the proposed base case for the Commission to pass to the CAISO for the annual TPP process, as well as a recommended sensitivity portfolio.

Activity	Timing
Ruling on 25-26 TPP (including proposed base case and recommended sensitivity, busbar mapping methodology, and RESOLVE updates)	September 2024
Comment review and production cost modeling of TPP portfolios	September-December 2024
Busbar Mapping by Working Group of portfolios	October-December 2024
Proposed Decision	December 2024-January 2025
25-26 TPP Adopted by Commission via Decision	January-February 2025

# **Input & Assumption (I&A) Updates for 25-26 TPP Modeling**

# Summary of Input Updates for 25-26 TPP

- IRP periodically updates its modeling inputs and assumptions to reflect new data, better modeling functionality, and other changes as needed.
- Updates for the 25-26 TPP modeling are compared to what was used in the 24-25 TPP portfolios adopted in D.24-02-047.

## Changes in Transmission and Interconnection Representation

- Added new resource interconnection limits in RESOLVE on each transmission constraint cluster based on number and voltage of buses in the cluster

## Load Inputs

- Switched from 2022 IEPR to 2023 IEPR
- Higher annual load and peak forecast, especially in 2035+

## Geothermal Resource Cost

- Binary technology represented instead of Flash
- 30% cost increase

## Arizona Solar Profiles

- Corrected Arizona Solar candidate resource profile to reflect daylight savings time adjustment

# Scope of Input Updates across TPP cycles

23-24 TPP	24-25 TPP	25-26 TPP (all cases)
<ul style="list-style-type: none"> <li>• Resource costs</li> <li>• Load inputs (2021 IEPR ATE)</li> <li>• Modeling resource Baseline</li> <li>• Updated NQC values</li> <li>• Transmission deliverability-resource mappings, existing transmission deliverability capacity, and transmission upgrade costs from CAISO 21-22 TPP and CAISO 20-year Study</li> <li>• Secondary system need (SSN) transmission utilization values, per CAISO</li> </ul>	<ul style="list-style-type: none"> <li>• Modeling resource Baseline</li> <li>• Resource cost (2023 NREL)</li> <li>• Load inputs</li> <li>• Resource potential PRM accounting &amp; resource accreditation</li> <li>• Sampling from SERVVM's 23-weather year dataset for loads and generation profiles</li> <li>• Resource-transmission representation &amp; deliverability upgrades based on CAISO data</li> <li>• Resource builds in non-CAISO external zones</li> <li>• Modeling and data updates for modeling load shift resources</li> <li>• Emerging technologies as candidate resources</li> </ul>	<ul style="list-style-type: none"> <li>• New Transmission Cluster Constraints</li> <li>• Load Inputs (2023 IEPR)</li> <li>• Geothermal Resource Cost</li> <li>• Arizona Solar Profiles</li> </ul>

# Changes in Transmission and Interconnection Representation in the 25-26 TPP

- For the 24-25 TPP, RESOLVE selected multiple GWs of resources at transmission clusters that are comprised of only a few individual substations.
  - Since those substations cannot accept such large capacity additions, many resources had to be relocated during Busbar Mapping.
- For the 25-26 TPP, additional constraints were added to the RESOLVE model to represent feasible limits on resource interconnection at the substation level.
- Substations are assigned a default interconnection capacity according to voltage, and limits are set for each cluster by summing across all substations.
- Individual substation expansions are not represented, but RESOLVE can choose to build generic transmission upgrades to interconnect highly economic resources.
- Actual mapping to individual substations or to a new substation, if warranted, is still performed in the Busbar Mapping process.

Substation Voltage (kV)	Default Interconnection Capacity (MW)
115	100
138	200
161	200
230	1,500
500	3,000

# Resource Cost Update

- The 24-25 TPP used flash geothermal costs from the 2023 NREL ATB.
- The 25-26 TPP uses binary geothermal costs from the 2023 NREL ATB as a more realistic technology for future geothermal build based on the IRP's current definition of candidate geothermal technologies.

Technology	Cases Used For	All-in fixed Cost (2022\$/kW-yr)
Geothermal – Flash	24-25 TPP	\$520/kW-yr
Geothermal – Binary	25-26 TPP	\$660/kW-yr

*~30% increase*

# Integrated Energy Policy Report (IEPR) Updates

- RESOLVE's load inputs were updated from CEC's 2022 IEPR CED to the 2023 IEPR CED (revised version). Updates include:
  - Annual energy
  - Gross peak
  - BTM resources
  - Hourly profiles
  - Associated changes in total reliability need and clean energy generation requirements for RPS, SB100 and SB1020
- The CEC produced the 2023 IEPR forecast for 2023-2040 while the TPP modeling horizon out to 2045, necessitating extrapolation of the CEC's load forecast.
  - Post-2040 extrapolation methods differ from methods used for the 24-25 TPP for the 2022 IEPR.
    - Supplemental data for 2041-50 was available to derive a growth rate for BTM resources.
    - The baseline was extrapolated using the growth rate for the last five years of data (2035-40); whereas the 2022 IEPR was extrapolated using the 2021 ATE forecast.

*The GHG Allowance Price was also updated to CED 2023 for the carbon price floor but had a negligible difference from the CED 2022 GHG Allowance Price*

# Summary of Changes in 2023 IEPR from 2022 IEPR

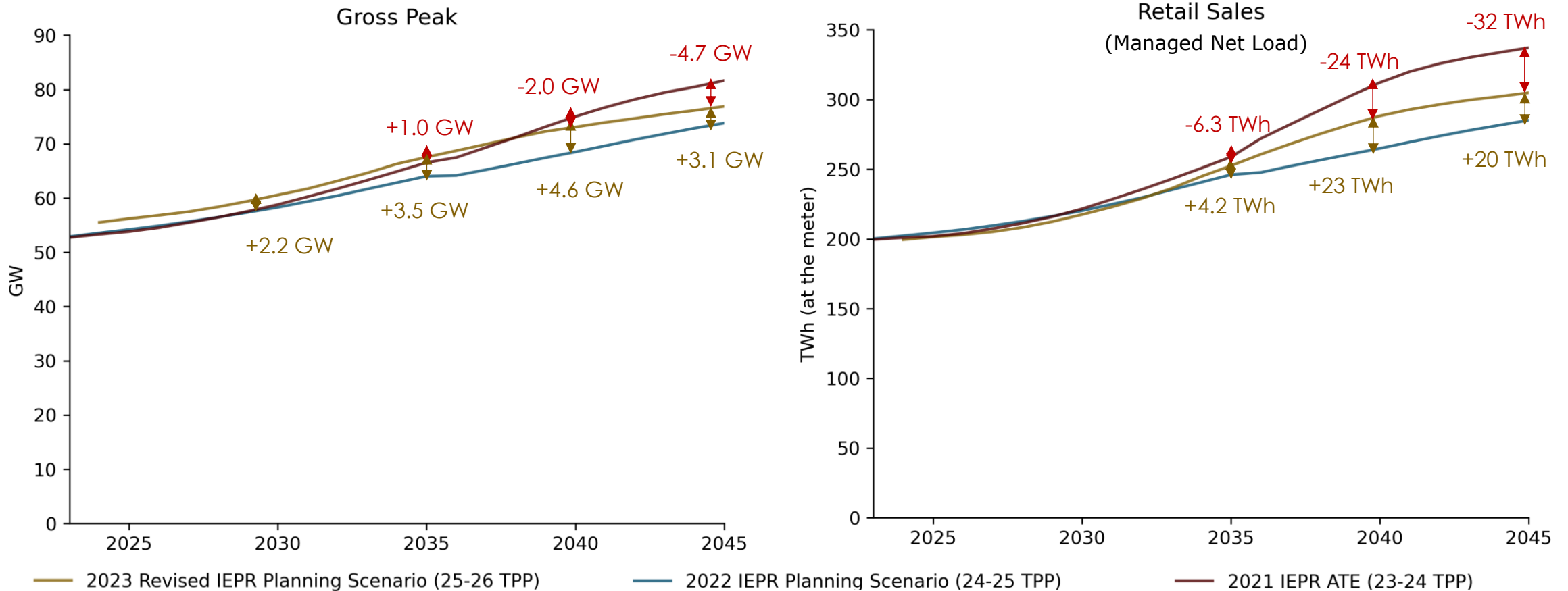
- The 2023 IEPR Planning Scenario shows higher retail sales and gross peak than the 2022 IEPR
  - The gross peak<sup>1</sup> in 2035 is 3.5 GW higher, and in 2045 is 3.1 GW higher in the 2023 IEPR forecast compared to the 2022 Forecast, an increase of 5% and 4%, respectively
  - Annual retail sales increase by 6.4 TWh in 2035, or 3%, and 20 TWh in 2045, or 7%
  - In the long-term, annual load grows faster than peak due to high rates of space heating electrification
- Higher retail sales and gross peak in the 2023 IEPR are driven by increased building electrification (AAFS) and lower energy efficiency (AAEE) impacts compared to 2022 IEPR. Additionally, the 2023 IEPR shows lower BTM PV adoption in the long term
- Managed net peak load shifts to winter in early 2040s due to building electrification
  - Building electrification loads are 4-5x higher in 2023 IEPR after 2035

# Extrapolation Methods

Component	2022 IEPR		2023 IEPR	
	2023-2035	>2035	2023-2040	2040-2050
Baseline	Published IEPR data	2021 ATE	Published IEPR Data	Linear growth rate
AATE and baseline transportation		Supplemental IEPR		Supplemental IEPR w/ interpolation
AAEE		Published Supplemental IEPR w/ interpolation	Published Supplemental IEPR	
AAFS				
Self-Generation		Linear growth rate	Published IEPR data	Linear
TOU		Flat	Embedded in baseline	

Notes:  
 "Published" data is provided publicly by the CEC.  
 Interpolation is applied when there is a discrepancy between the core published and supplemental data requiring a smoothing out of any discontinuities in the forecast.

# Gross System Peak and Total Managed Retail Sales



Note: Gross peak is Managed Net Load + BTM PV

Note: Assumes no CHP retirement

# Post-25-26 TPP Modeling I&A Updates & IRP Process

- IRP Staff will be updating the inputs and assumptions used IRP modeling in preparation for modeling to support IRP issuing LSE Filing Requirements.
- Upcoming IRP I&A and other milestones are as follows:
  - IRP Staff release Draft I&A
    - IRP Staff initiate I&A Stakeholder process, including a stakeholder workshop and reviewing informal stakeholder comments on Draft I&A, following that release.
  - IRP Staff release the Final I&A and issue Filing Requirements for LSEs to use in developing 2025 IRPs.
  - LSEs submit individual IRPs on November 1, 2025.

# 25-26 TPP Proposed Base Case Portfolio

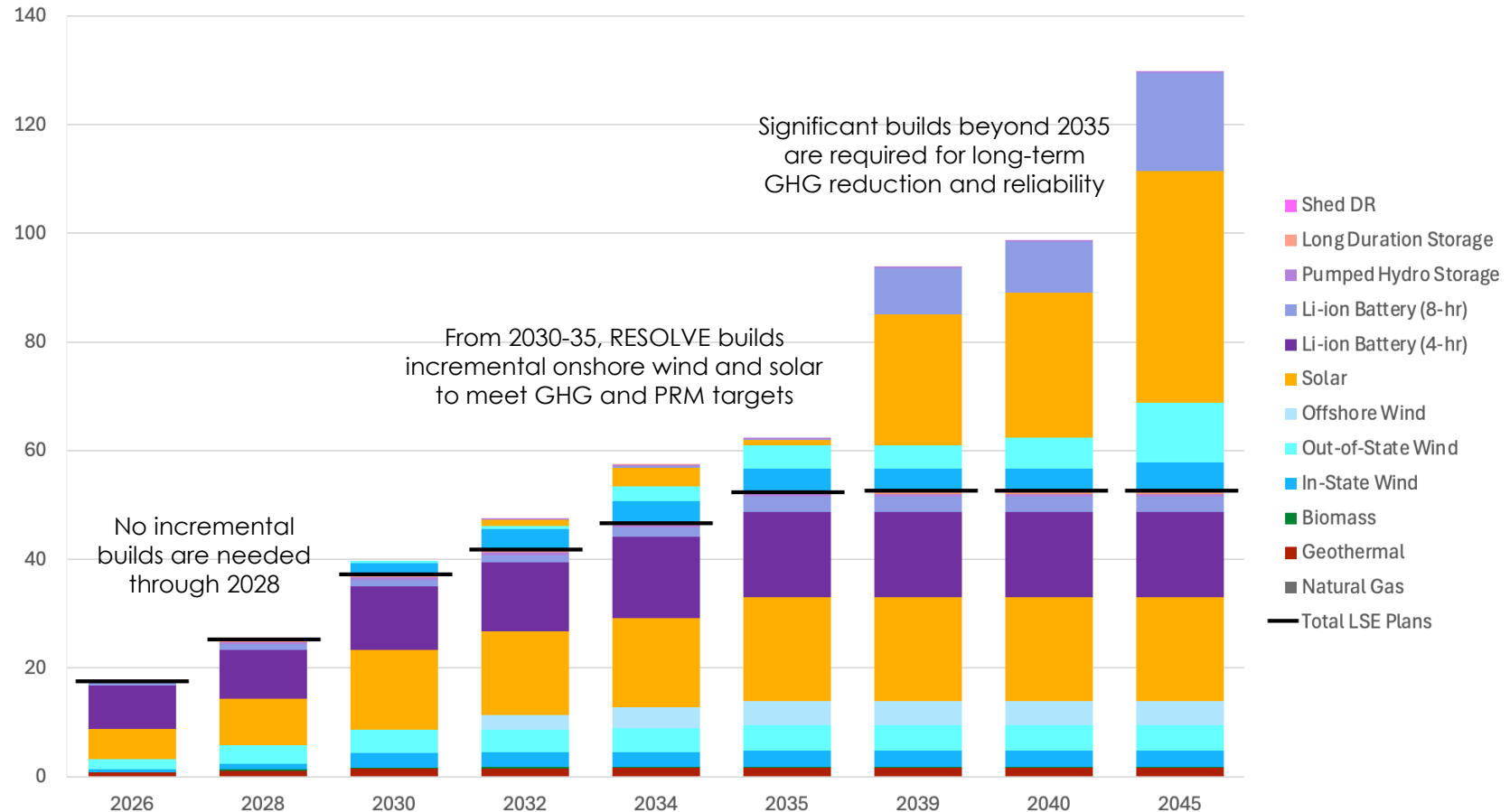
# Proposed 25-26 TPP Base Case Overview

- Proposed base case designed to be similar the 2024-25 TPP base case with same key policy assumptions.
  - Incorporates the 25 MMT GHG target by 2035 (same as for the 24-25 TPP).
  - Includes LSE plans submitted in their November 2022 IRP filings (same as for the 24-25 TPP).
  - Using same resource baseline and Inputs & Assumptions outside of the changes noted earlier.
  - Updated to the 2023 IEPR Planning Scenario (24-25 TPP base case used the 2022 IEPR Planning Scenario).
- Key model years for busbar mapping and transmittal to CAISO
  - 2035 — 10-year projection
  - 2040 — 15-year projection

# 25-26 TPP Proposed Base Case

## LSE Planned Builds vs. RESOLVE-Selected Builds (GW)

LSE Plans & RESOLVE-Selected Capacity (GW)



Capacity above the black line is incremental, selected by RESOLVE

Capacity below the black line is part of the LSE Plans\*

\* LSE plans only go out to 2035

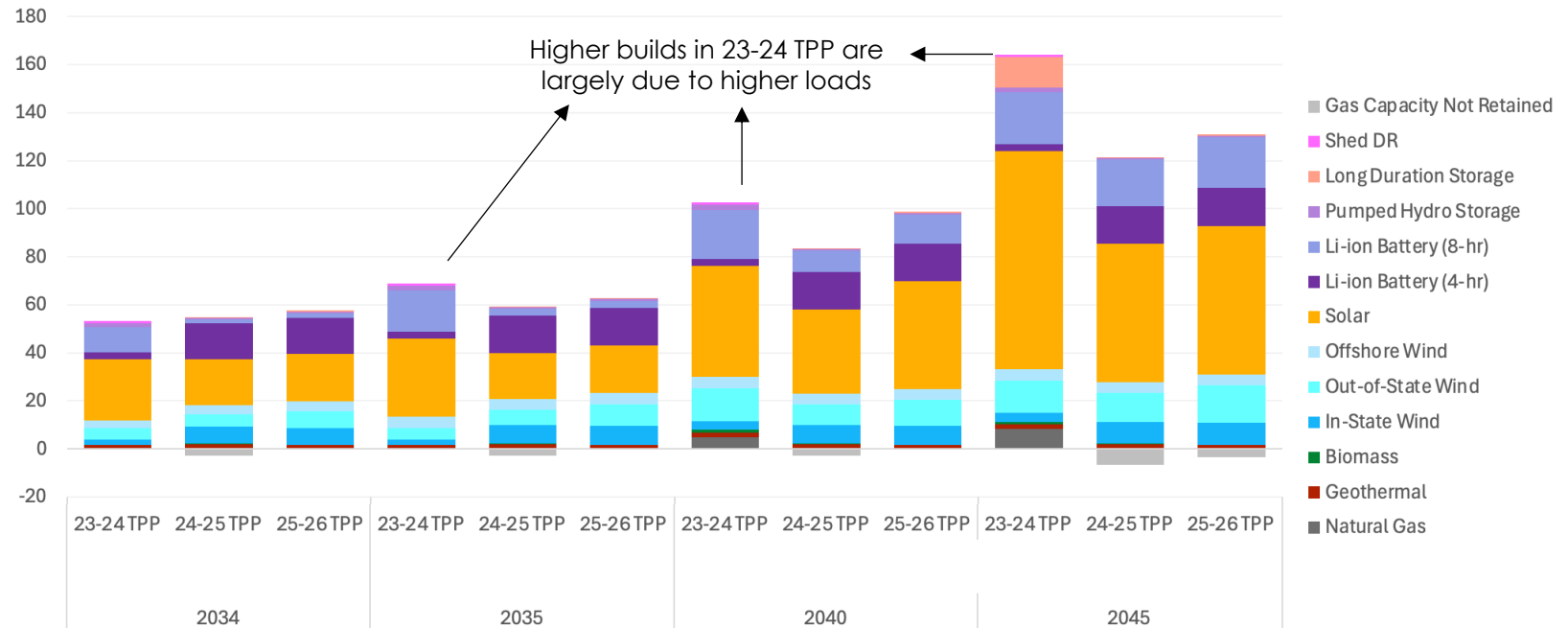
Note: A portion of LSE Planned wind is generic (not specified as in-state or out-of-state) and can be sited optimally by RESOLVE. For the purposes of this graph, any generic wind in the LSE plans is allocated based on the share of RESOLVE-selected wind in 2035 (approximately 50% each in-state and out-of-state).  
 Note: All Capacity is incremental to the 2023 Baseline ([https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/aggregated-lse-plans-and-baseline-resources-2023-psp\\_v2.xlsx](https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/aggregated-lse-plans-and-baseline-resources-2023-psp_v2.xlsx))

## Comparison of 23-24 TPP, 24-25 TPP, 25-26 TPP Proposed Case

# Comparison of Planned & Selected Capacity (GW)

- Differences in resource buildout are driven by differences in **load, resource economics, and GHG targets**
- The 23-24 TPP used the 2022 NREL ATB, which did not reflect IRA incentives or significant increases for battery cost in recent years as a result.
- The 2021 IEPR (used in 23-24 TPP) has significantly higher (8-12%) annual loads by 2045, which combined with different resource economics modeled, results in **significantly larger amounts of solar and long duration storage in 23-24 TPP\***
- The **23-24 TPP** has a less stringent GHG target by 2045 (15 MMT vs. 8 MMT), allowing for **new gas build**
- All three TPP portfolios have **similar amounts of geothermal, out-of-state wind, and offshore wind** build
  - 23-24 TPP was modeled with lower in-state wind potential, which led to lower amounts of in-state wind build

**RESOLVE Builds Across Portfolios**  
(GW)



Note: 23-24 TPP modeled 4-hr and 8-hr batteries in aggregate; these are separated for the purpose of this analysis based on the average battery duration of the 23-24 TPP portfolio

Note: 2023 builds and other baseline differences in 23-24 TPP are removed in results shown to enable more consistent comparison

\*Long Duration Storage in the 23-24 TPP are 8-hour Flow Batteries, which were not subject to transmission constraints. Biomass was also not subject to transmission constraints in the 23-24 TPP

\*\*2045 is not used in the TPP planning portfolio

# Conclusions

- Compared to the **2022 IEPR**, the **revised 2023 IEPR has higher demand and peak load**, driving an **increase in resource buildout**
  - By 2040, the **25-26 TPP** has **10.6 GW more solar**, **3.2 GW more 8-hr battery storage**, and **2.7 GW more gas retained** than the 24-25 TPP
  - The revised 2023 IEPR also has **higher winter loads**, which drives a shift from in-state wind and solar to out-of-state wind
- The transmission constraint updates have also contributed to a **shift in location** of some resource buildout and geothermal cost updates have **slightly reduced the geothermal selected** by RESOLVE

# **Staff Recommended Option for the 25-26 TPP Sensitivity Portfolio**

# Background – Purpose of Sensitivity

- In addition to the Proposed 25-26 TPP Base Case, Staff are proposing to pass one sensitivity portfolio to the CAISO focused on a higher Long Lead-Time (LLT) resource deployment future.
  - Considered two options for the sensitivity portfolio: the Staff Recommended and the Alternate sensitivity portfolios.
- The recently adopted AB 1373 related Decision (D.) 24-08-064 contained a need determination for specific LLT resources for potential procurement by the Dept. Of Water Resources.
  - Identified a need for up to 7.6 GW of offshore wind (OSW), 2 GW of long duration energy storage (LDES), and 1 GW of geothermal in addition to existing procurement orders.
  - The amounts of OSW and LDES have not previously been studied in any TPP base case or in a sensitivity case that reflected a reasonable alternate scenario to the TPP base case.\*
- The two potential sensitivities options both depict a potential LLT resource deployment future reflective of the upper bound of the AB 1373 Decision need determination.
  - Designed to serve as reasonable alternative scenarios associated with the proposed base case.
  - Provide insights into transmission implications and resources that are displaced from more LLTs being in the portfolio.

\*While the 23-24 TPP OSW Sensitivity included 13.4 GW of OSW and the 24-25 TPP High Gas Retirement Sensitivity included 3.7 GW of LDES, both portfolios were designed to gather long-term transmission information to inform future scenarios and do not reflect a likely deployment of the specific resources over the timeframe of the TPP studies.

# Background – LLT Resource Amounts

- The two potential sensitivity options both differ from the proposed base case assumptions by having **additional Long Lead-Time (LLT) resources forced-in**, specifically geothermal, long duration energy storage (LDES), and offshore wind (OSW)) by 2035.\*
  - Both options have the same total amount of OSW, geothermal, and LDES resources (see table below)
  - The OSW, geothermal, and LDES resource amounts reflects the upper bound of the potential LLT resources indicated for central procurement in the AB 1373 Decision (D.24-08-064).
  - Total amounts also account for the clean firm and long duration storage procurement requirements per the Mid-Term Reliability (MTR) Decision (D.21-06-035) adjusted for such resources already contracted and included in baseline.<sup>1</sup>
  - Amounts assume little to no additional procurement by LSEs beyond MTR and AB 1373 Decision amounts for specified LLT resources (e.g., the 7.6 GW of OSW is the total amount modeled, including LSE plans)
  - LDES resources are represented as A-CAES and Pumped Hydro (the two 12+ hr duration storage resource options modeled in RESOLVE)
- More information about the Alternate portfolio is available in the [deck](#) IRP staff released with the Ruling, but will not be covered in today’s workshop.

Case Name	Portfolio Name	Year LLTs forced-in*	Geothermal Build (MW)	A-CAES Build (MW)	Pumped Hydro Build (MW)	Offshore Wind Build (MW)	LSE Plan Configuration
	25-26 TPP Base Case	-	1,639	200	756	4,531	Full LSE plans
Alternate	LLT (2035 LSE Plans)	2035	2,139	900	1,777	7,555	Full LSE plans
<b>Recommended</b>	LLT (2030 LSE Plans)	2035	2,139	900	1,777	7,555	LSE plans through 2030

\*Forced-in Geothermal, A-CAES, and Pumped Hydro may be selected by the model any time 2031-2035

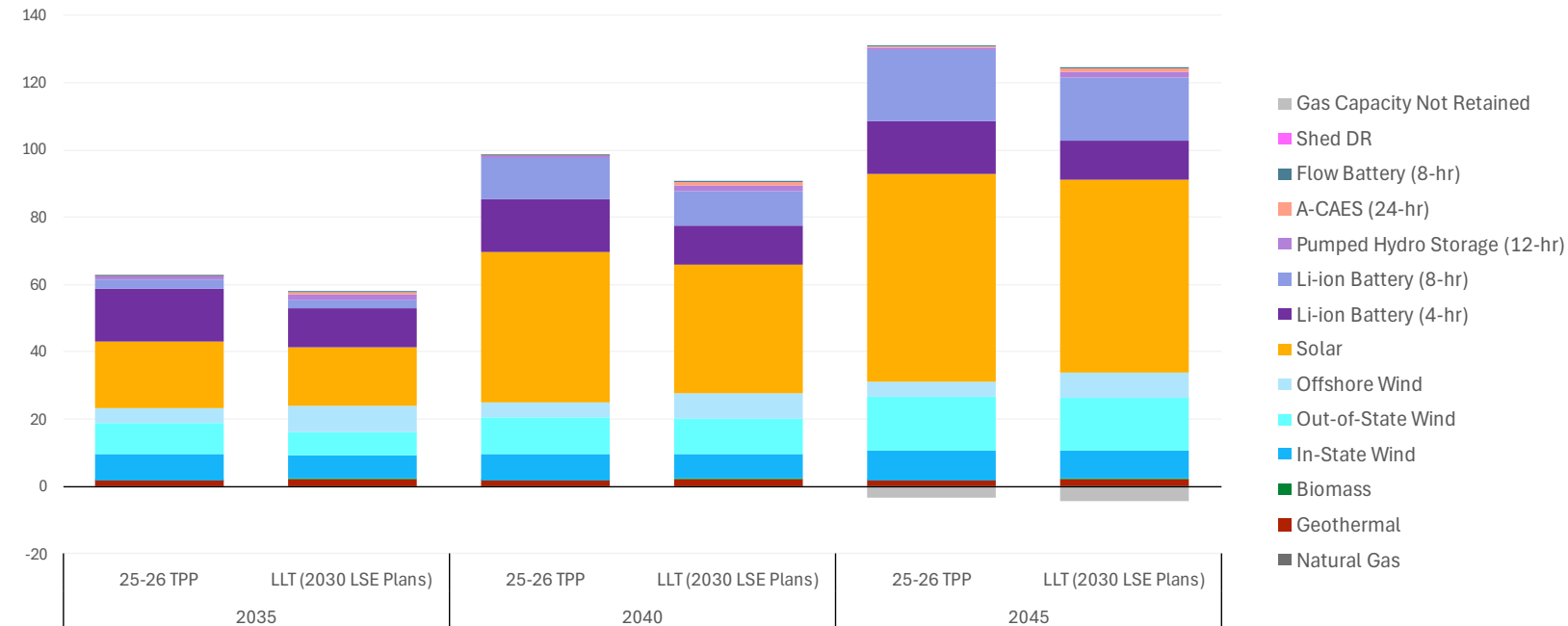
<sup>1</sup> The modeling baseline for this analysis is available here: [https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/aggregated-lse-plans-and-baseline-resources-2023-psp\\_v2.xlsx](https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/aggregated-lse-plans-and-baseline-resources-2023-psp_v2.xlsx)

# Recommended – LLT (2030 LSE Plans) vs. 25-26 TPP Proposed Base Case

## Comparison of Planned & Selected Capacity (GW)

- The additional **5.5 GW** of LLT resources added in 2035 **displaces ~13 GW** of other resource builds by 2040
- Compared to the 25-26 TPP, **starting in 2035, about ~1 GW less solar and battery is built annually** when additional, high-capacity factor LLT resources are added to the system
- **2 GW out-of-state wind is delayed** from 2035 to 2040
- By 2040, the LLT case has **similar amounts of onshore wind** (<1 GW differences)
- **All gas is retained until 2045.** In 2045, gas not retained totals 3.5 GW in the 25-26 TPP and ~4.4 GW in the LLT case
- Forcing-in additional LLT resources **increases total NPV costs by ~\$3 Billion**

RESOLVE Builds Between TPP Proposed Base Case and Recommended TPP Sensitivity Portfolio



### NPV of optimized costs\* (\$MM in 2022 Dollar Year, 2024-2065)

LLT (2030 LSE Plans)	\$231,930 <b>(+\$3,253 MM or +1.4%)</b>
25-26 TPP Proposed Base Case	\$228,677

### Annual Optimized Costs (\$MM)

	2035	2040	2045
LLT (2030 LSE Plans)	15,232 <b>(+\$468M)</b>	18,449 <b>(+\$312M)</b>	20,232 <b>(+\$390M)</b>
25-26 TPP Proposed Base Case	14,764	18,137	19,842

\* Excludes non-optimized costs, which represent ~75-80% of system costs

# Conclusions

- When forced-in, **5.5 GW LLT** resources displace **~12-13 GW** of other lower capacity factor resources by 2040, primarily **solar** and **storage** and some **in-state wind**.
- When given the option to build forced-in 2035 amounts of geothermal and long duration storage earlier, RESOLVE starts building these resources in 2032.
  - These LLT resources can **displace more solar and storage when built earlier**.
- When LLT resources and **full LSE plans** are forced-in, the system ends up over-reliable and RESOLVE has **less flexibility for LLTs to displace solar and storage in 2035**.
  - This leaves onshore wind as the main resource that can be displaced with full LSE plans forced-in.
- In 2045, LLT sensitivities have **1 GW less gas retained** than in the 25-26 TPP case.
- Forcing-in additional LLT resources **increases total (net present value) costs by ~\$3-5 Billion**.
- **Staff recommend LLT (2030 LSE Plans) – which only forces in the LSE planned resources through 2030 – for the 25-26 TPP LLT Sensitivity Portfolio.**

# Busbar Mapping Methodology

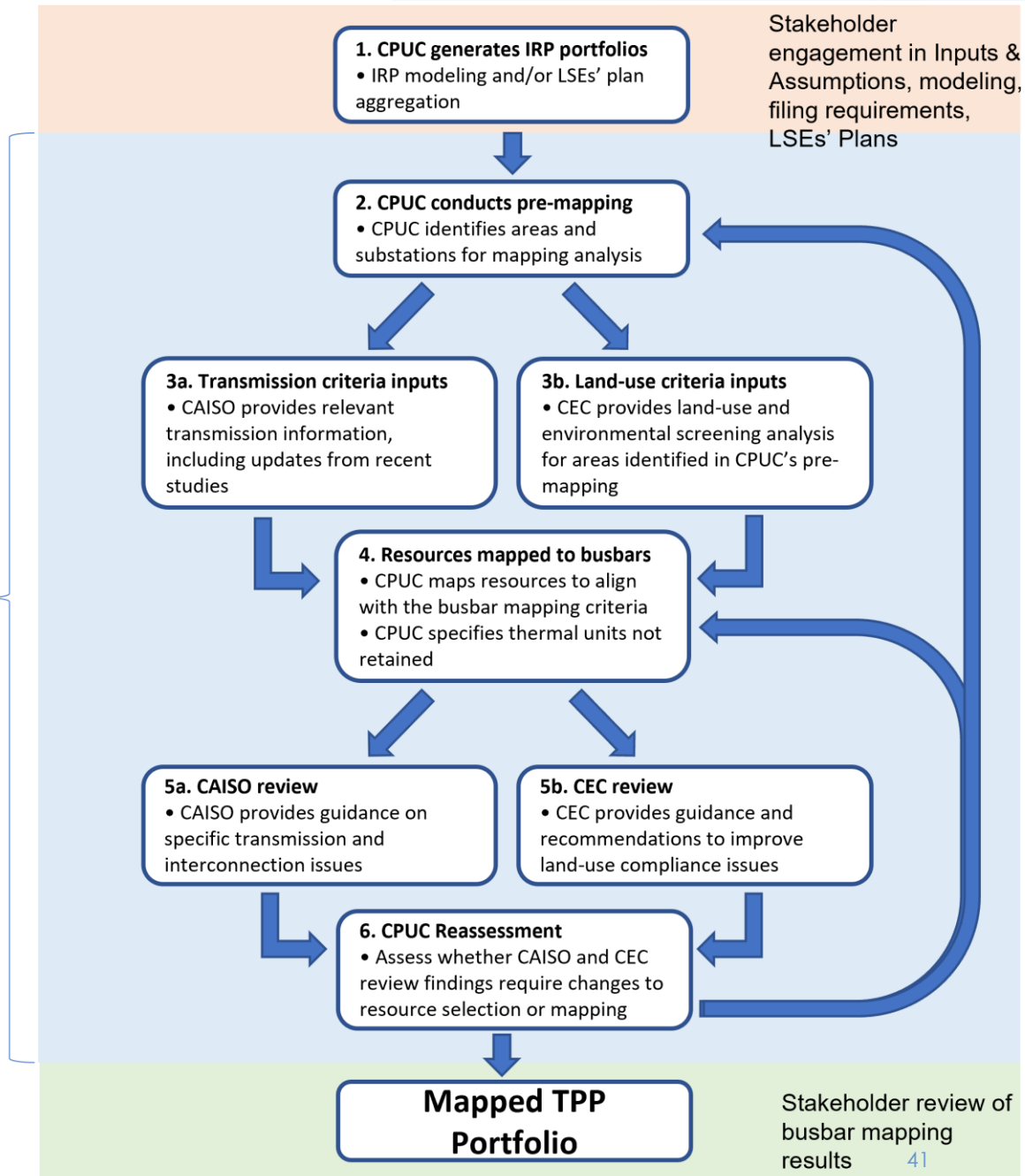
# Busbar Mapping Methodology

- **Busbar Mapping Methodology:** Methodology document states guiding principles, establishes mapping criteria, and outlines the iterative inter-agency mapping process.
  - Current [Mapping Methodology for the 25-26 TPP](#).
- **Updates included in Current Methodology:** After significant changes to the mapping methodology for the 24-25 TPP, staff implemented smaller updates this cycle. Those updates included:
  - Inclusion of the full criteria for fossil fuel plant not retained selection (currently reviewing significant feedback from stakeholders on how to further update these criteria)
  - Addition of Environmental & Land-use criteria for potential pumped-storage locations
  - Clarifications and corrections on how certain data was incorporated and used in the criteria, including for non-queue info for commercial interest, in-development and contracted resource mapping, CEC data sources for land-use and environmental screens, and treatment of out-of-CAISO resources
- **Future Methodology updates:** Staff anticipate conducting more updates to the methodology for the next cycle, particularly to better reflect the CAISO's interconnection reforms.
  - Sept. 12 ruling included several questions regarding potential changes for future cycles.
  - Staff anticipate conducting a methodology update process with stakeholder engagement similar to the effort preceding the 24-25 TPP ruling.

# Busbar Mapping Process

- Busbar Mapping can be viewed as a sequence of steps involving CPUC, CEC, and CAISO staff providing inputs and expertise at various stages.
  - CEC staff provide land-use and environmental information, data analysis, and implications assessment.
  - CAISO staff provide similar info for transmission and interconnection topics.
  - CPUC applies analysis and information to conduct the mapping itself and coordinates the information transfers.
- Overall process is an iterative effort that requires several rounds of the mapping process
- Goals of the mapping process:
  - Identify plausible locations for portfolio resources that align with CPUC policy requirements, maintain reliability, and minimize cost to ratepayers.
  - Align mapped resources to the extent feasible with the guiding principles and the mapping priorities of each criteria.

Methodology addresses these steps



# RESOLVE Resource Regions and CAISO Study Areas

- Figure shows the RESOLVE resources regions for solar and storage (onshore wind resources are broken down into further sub-areas).
- CAISO's ten transmission study areas do not fully align perfectly with these regions with some study areas split between RESOLVE regions.

RESOLVE region	CAISO Study Area(s)
Northern California	PG&E North of Greater Bay & PG&E Greater Bay
Southern PG&E	PG&E Fresno & PG&E Kern
Greater Tehachapi	Part of SCE Northern
Greater LA Metro	SCE Metro & Part of SCE Northern
Greater Kramer	SCE North of Lugo
Southern Nevada	East of Pisgah
Riverside	Part of SCE Eastern (excluding AZ buses)
Arizona	Part of SCE Eastern and Part of SDG&E
Greater Imperial	Part of SDG&E
San Diego	Part of SDG&E



# Mapping Criteria Overview

- The mapping Methodology, used since the 24-25 TPP portfolios, has the busbar mapping criteria organized into seven categories:
  1. System level transmission capability
  2. Substation level interconnection viability
  3. Land-use implications and feasibility factors
  4. Environmental (conservation and biological) impact factors
  5. Environmental (societal) and community impact factors
  6. Commercial & development interest
  7. Consistency with prior TPP portfolios
- Staff rank criteria alignment using a five-level scale to summarize mapped resources' alignment with the various criteria priorities.
  - Not all criteria screens use all five levels of alignment.

Level 1	Level 2	Level 3	Level 4	Level 5
Strong compliance with criteria; alignment with criteria's prioritized conditions	Mostly favorable compliance with criteria; not fully aligned with priorities but not near to triggering unfavorable criteria	Mixed compliance with criteria; little alignment with priorities; potential alignment with conditions criteria seek to limit or avoid	Some noncompliance with criteria; some alignment with conditions criteria seeks to limit or avoid	Significant noncompliance with criteria; no alignment with stated criteria; meets conditions criteria seek to limit or avoid

# System Level Tx Capability Criteria Analysis

- Mapped resources should abide by the estimated system level transmission constraints, triggering only those upgrades which are determined to be cost-effective or necessary to meet policy and reliability requirements.
- Mapping uses information from the new CAISO White Paper – 2024 Transmission Capability Estimates for use in the CPUC’s Resource Planning Process.
  - [Link](#) to 08/29/2024 White Paper and appendices
  - Adds more substations and updates constraint info, including approved upgrades from recent TPPs.
- Analysis incorporates on-peak and off-peak limits and identified upgrades for CAISO transmission constraints
  - Actual constraints (binding amounts identified in CAISO studies) and Default constraints (non-binding limits – largest amount CAISO has studied)
- Identify mapped OOS resources as utilizing existing Maximum Import Capability (MIC) or require MIC expansion

Tx Capacity Utilized by Mapped Resources (MW)	Kramer- Victor/Roadway - Victor Constraint			Kramer- Victor/Roadway - Victor Constraint			Lugo 500/230 kV Transformer Constraint		
	HSN	SSN	Off-Peak	HSN	SSN	Off-Peak	HSN	SSN	Off-Peak
<b>Existing Capacity:</b>	<b>826</b>	<b>826</b>	<b>1,237</b>	<b>1,156</b>	<b>1,156</b>	<b>1,311</b>	<b>1,576</b>	<b>1,576</b>	<b>1,619</b>
Wind	-	-	-	-	-	-	-	-	-
Solar	103	415	1,567	114	457	1,644	145	585	2,053
Geothermal	53	53	-	53	53	-	53	53	-
Biomass	-	-	-	25	25	-	25	25	-
Li_Battery	1,029	514	(1,029)	1,079	539	(1,079)	1,264	632	(1,264)
<b>Total Utilized:</b>	<b>1,185</b>	<b>982</b>	<b>539</b>	<b>1,270</b>	<b>1,075</b>	<b>566</b>	<b>1,487</b>	<b>1,295</b>	<b>789</b>
<b>Remaining:</b>	<b>(359)</b>	<b>(156)</b>	<b>698</b>	<b>(114)</b>	<b>81</b>	<b>745</b>	<b>89</b>	<b>281</b>	<b>830</b>
<b>Tx Upgrade Amt:</b>	<b>430</b>	<b>430</b>	<b>480</b>	<b>430</b>	<b>N/A</b>	<b>N/A</b>	<b>980</b>	<b>N/A</b>	<b>N/A</b>



**Flags without (left) and with (right) upgrades**

Total Resources (MW) by Substation		Geothermal	Biomass	Distributed Solar	Solar	Solar	Li_Battery	Tx Criteria Flag	Tx Criteria Flag	Tx Criteria Flag	Tx Criteria Flag
Substation	Voltage	FCDS	FCDS	FCDS	FCDS	EODS	FCDS	FCDS	EODS	FCDS	EODS
Calcite	230	-	-	-	200	230	185	1	1	1	1
Control	115	53	-	-	-	-	-	3	1	1*	1
Coolwater	115	-	-	-	150	204	104	3	1	1*	1
Kramer	230	-	-	-	620	741	700	3	1	1*	1
Kramer	115	-	-	2	90	-	75	3	1	1*	1
Pisgah	230	-	-	-	100	-	-	1	1	1	1
Roadway	115	-	-	3	111	120	150	3	1	1*	1
Victor	230	-	3	2	100	-	50	3	1	1*	1
Victor	115	-	22	-	-	-	-	3	1	1*	1

**Table:** 23-24 TPP non-compliance flags determined from transmission constraints utilization calculations

# Substation-level Interconnection Criteria

- Mapped resources should
  1. Be within a viable distance of transmission from economic, land-use, and environmental perspectives and
  2. Be able to interconnect to transmission of an appropriate voltage in a viable and cost-effective manner.
- Initial mapping analysis includes only:
  - Distance from substation for in-CAISO solar, onshore wind, and geothermal resources
  - Interconnection voltage analysis for in-CAISO solar, onshore wind, and storage resources
- For key substations, staff plan to work with CAISO staff and PTOs to obtain potential information on ease and costs of interconnection, including:
  - Number of open positions on existing buses.
  - Ability to allow additional interconnections or substation expansion (e.g., stations at or near fault duty limit, maximum generation capabilities, physical space or technical limitations to expansions/upgrades).
  - Cost/ease of expanding substation’s interconnection ability (e.g., in-fence line upgrades, substation expansion options).

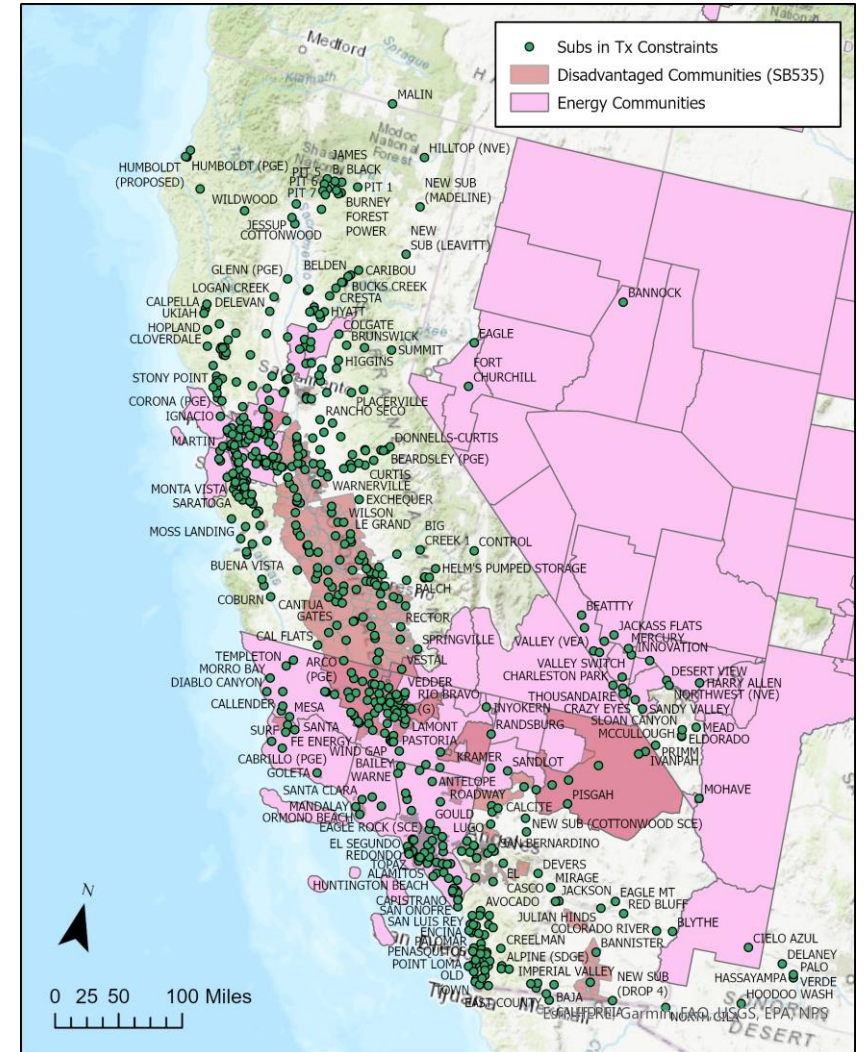
**Criteria Alignment levels for Distance to interconnection**

Level	Wind & Geothermal		Solar	
	< 200 MW	200 MW or more	< 400 MW	400 MW or more
1	<10 mi	<10 mi	<5 mi	<10 mi
2	<15 mi	<20 mi	<10 mi	<15 mi
3	<20 mi	<30 mi	<15 mi	<20 mi
4	<30 mi	>30 mi	<20 mi	<30 mi
5	>30 mi	-	>20 mi	>30 mi

Level	Interconnection Substation Voltage			
	Less than 100 kV	100 - 200 kV	230 or 345 kV	500 kV
1	-	<50 MW	>200 MW & <1,500 MW	>400 MW & <3,000 MW
2	-	<100 MW	>50 MW & <2,000 MW	>200 MW & <3,000 MW
3	<50 MW	<200 MW	>50 MW & <3,000 MW	>200 MW & <4,000 MW
4	<100 MW	<400 MW	>3,000 MW	<200 MW or >4,000 MW
5	>100 MW	>400 MW	<50 MW	<100 MW

# Community and Environmental (societal) Impacts Criteria Analysis

- Mapped resources should seek to bolster and benefit pollution-burdened and disadvantaged communities where feasible, particularly with the goal of reducing reliance on fossil-fuel generators.
- Looks at datasets centered around seeking to map renewable resources and energy storage to bolster and benefit pollution-burdened and historically disadvantaged communities, particularly by seeking to reduce emissions and impacts of air-pollutant emitting fossil-fuel generators.
  - Proximity to fossil-fueled generators
  - Air Quality Standard Non-Attainment Areas – Ozone and PM2.5
  - Areas in or near disadvantaged communities (per SB 535 and CalEnviroScreen 4.0 dataset)
  - Areas in Inflation Reduction Act Energy Communities
- Also seek to limit impacts of new emitting resources (e.g. biomass) to these communities.
  - Criteria Alignment is reversed for biomass/gas mapping.



**Above:** Map show substation locations overlaid with identified disadvantaged communities and energy communities.

# Commercial Interest Criteria Analysis (1/2)

- Mapping, to extent possible, should align with planned procurement by LSEs and the level of resources proposed in the CAISO and other relevant interconnection queues.
- Incorporates information from
  - the CAISO’s queue, PTOs’ WDT queues, and other BAA queues (e.g., Imperial Irrigation District and Nevada Energy)
  - Non-queue interest including leasing status (e.g., offshore wind) and permitting status (e.g., pumped storage at FERC) are considered
- The criteria prioritizes alignment with confidence of being brought online:
  - “In-development resources” — Resources contracted, under-construction, or progressing through the new resource implementation (NRI) interconnection process.
  - “Higher-confidence” commercial interest — Resources with executed interconnection agreements, CAISO transmission plan deliverability (TPD) allocations, and lastly resources with CAISO Phase 2 completed.
  - “Lower-confidence” commercial interest — Resources that have only completed or are still in initial study/queue application phases.

All Values in Nameplate MWs	Resources in CAISO interconnection queue (10/07/24) — Excluding identified already online, contracted, and in-development resources			
	Total Resources	Executed IA	Has TPD	In Near-term Interconnection List
Geothermal	37	9	28	-
Onshore Wind	3,846	2,589	827	2,954
Offshore Wind	6,053	1,029	3,250	1,191
Solar	40,534	14,562	3,234	11,378
Battery	81,960	20,917	37,228	17,747
LDES	2,749	1,332	1,265	520
<b>Total:</b>	<b>135,180</b>	<b>40,439</b>	<b>45,832</b>	<b>33,790</b>

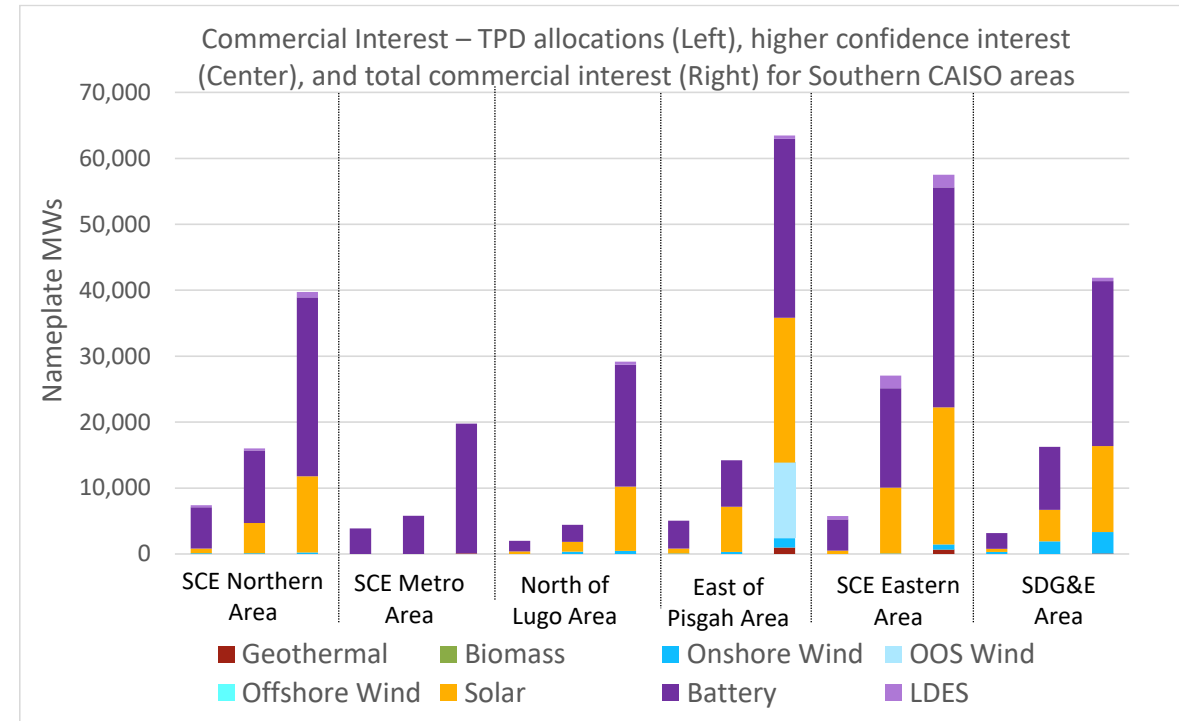
**Above:** Commercial interest from CAISO’s interconnection queue.

**Below:** Identified in-development resources not in modeling baseline.

In-Development Res. by CAISO study area	Geothermal (MW)	Biomass (MW)	Wind (MW)	OOS Wind (MW)	Distributed Solar	Solar (MW)	4hr - Battery (MW)	8hr - Battery (MW)	Other LDES (MW)	Total (MW)
PG&E North of Greater Bay	25	3	-	-	15	28	121	-	5	197
PG&E Greater Bay	-	3	91	-	6	100	588	-	-	788
PG&E Fresno	-	2	61	-	50	1,887	2,110	35	-	4,144
PG&E Kern	-	-	-	-	19	863	401	-	-	1,283
SCE Northern	-	-	-	-	24	1,810	2,979	6	200	5,019
SCE Metro	366	6	-	-	13	20	1,429	10	-	1,843
SCE North of Lugo	10	-	-	-	17	515	379	6	-	926
East of Pisgah	-	-	-	51	-	775	1,210	-	-	2,036
SCE Eastern	-	3	57	1,685	-	3,474	3,818	100	-	9,137
SDG&E	-	-	-	-	1	1,074	1,550	-	-	2,625
<b>Total In-Dev:</b>	<b>401</b>	<b>16</b>	<b>208</b>	<b>1,736</b>	<b>144</b>	<b>10,544</b>	<b>14,585</b>	<b>157</b>	<b>205</b>	<b>27,996</b>

# Commercial Interest Criteria Analysis (2/2)

- Criteria alignment assesses both if mapping exceeds commercial interest or if it is significantly less than the commercial interest on a bus level.
- Analysis focuses on mapped generic resources only.
  - Initial step of mapping is mapping to align with in-development and online resources to ensure inclusion.
  - Online and in-development resources are then identified in their respective queues and removed from the commercial interest amounts.



**Above:** Commercial interest amounts in Southern California study areas, summarized by select confidence levels: TPD allocated, higher confidence, and total commercial interest. Within each region, each column is inclusive of the columns on its left.

Criteria		Level 1	Level 2	Level 3	Level 4	Level 5
Commercial Development Interest	MW amount exceeds CI	Aligns with TPD or IA resources	Exceeds TPD/IA Res but aligns with total higher confidence CI	Exceeds higher confidence CI but not total CI	Exceeds total CI	No CI at substation
	MW amount less than CI	1+ amount mapped is significantly less than total CI	2+ Amount mapped is less than than high confidence CI	3+ Amount mapped is less than TPD/IA/ Res	4+ Amount mapped is significantly less than TPD/IA/ Res	5+ Amount mapped is less than In-development Res

# Baseline Reconciliation and In-development Resources

- Staff need to conduct a reconciliation process to account for resources that are not in both the modeling baseline and the transmission constraints baseline to ensure both resources amounts and transmission utilization are properly accounted for.
- Staff utilize this process to also identify the in-development resources to align with in mapping.

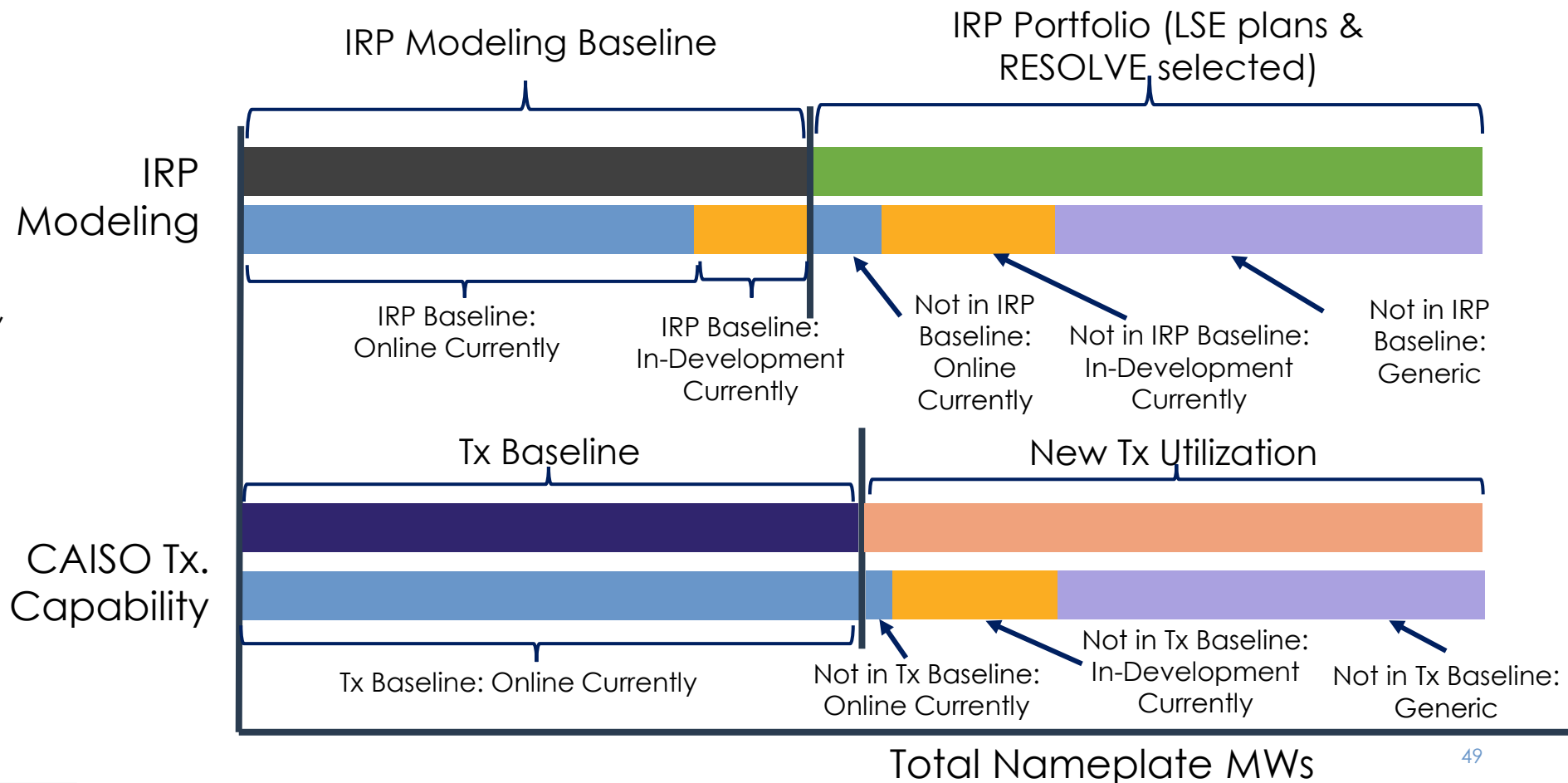
## Busbar Mapping Resources

### Categories:

**Online:** Resources identified in the CAISO Master Generating List at time of mapping.

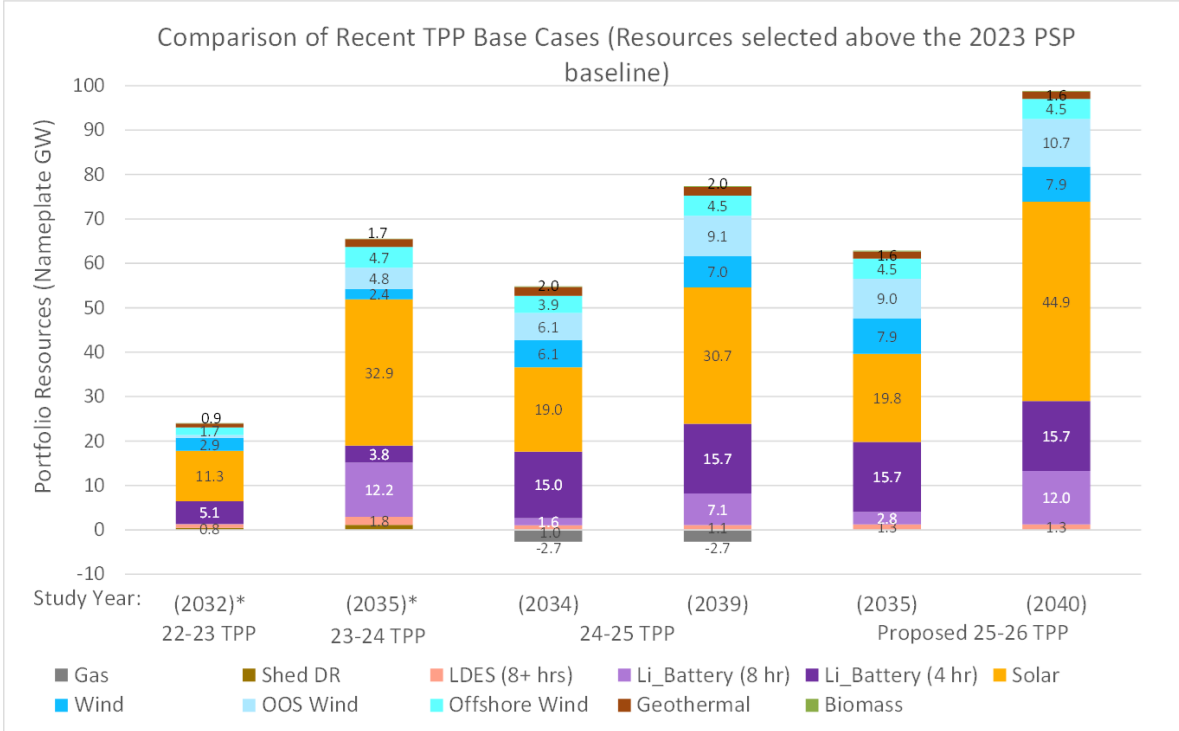
**In-Development:** Resources contracted, under construction, or already progress through the interconnection process that have very high confidence of development to online.

**Generic:** Resources in the portfolio (either from LSE plans or RESOLVE selected) that are not tied to a specific project.



# Alignment with prior TPP portfolios

- Mapping should be relatively consistent with prior years.
  - The Base Case compared to base cases of prior years and similar sensitivity portfolios.
  - Sensitivity Portfolios compared to similar issue-focused portfolios of prior years.
- Goal is to avoid significantly reducing transmission impacts of prior years' mapping without clear reasons which are explicitly justified.



Above: Comparison of recent base case portfolios and the proposed 25-26 TPP base case.

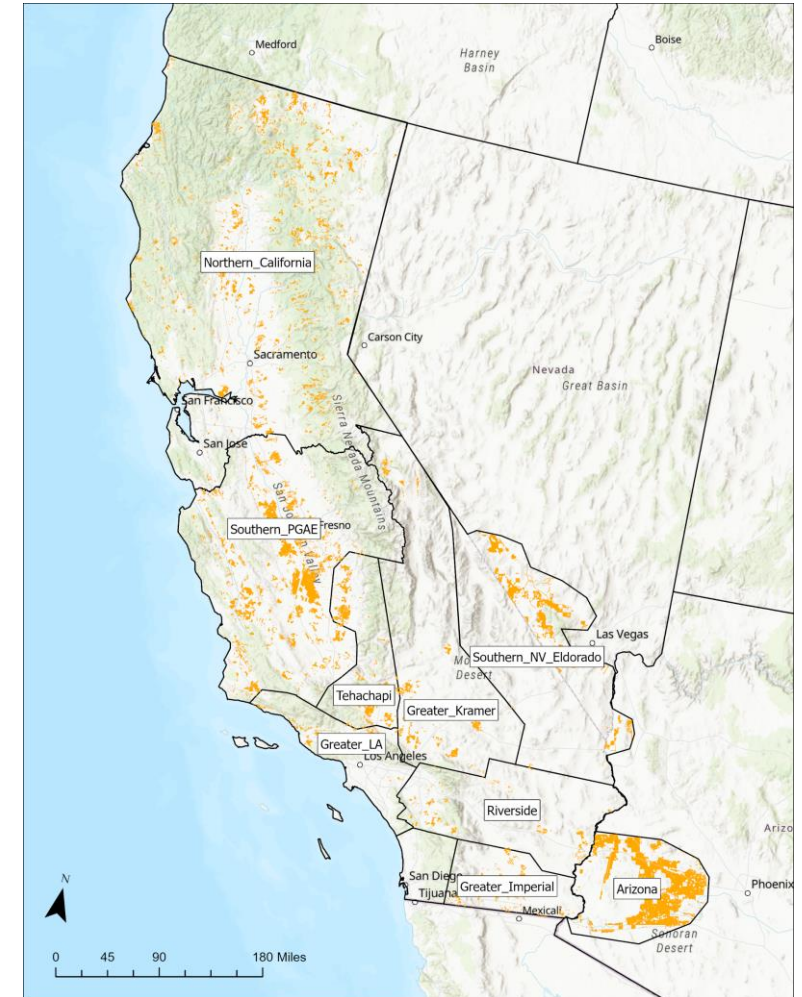
Criteria	Comparative Point(s)		Level 1	Level 2	Level 3	Level 4	Level 5
Consistency with prior TPP Portfolios	Previous TPP portfolios mapped resources	MW amounts mapped	Not less than in previous most similar TPP portfolio	Not less than (FCDS & Total) total in previous base case	Slightly less FCDS or total than in previous base case	Significantly less total than in previous base case	Level 4 but in area with approved/triggered Tx upgrade

# Mapping Methodology for Modeled Gas Retirements

- Portfolios can include two types of gas retirements:
  - Policy-identified retirements that are forced into RESOLVE and do not appear as RESOLVE-selected resources
  - RESOLVE-selected generation not retained due to RESOLVE's economic costs optimization, which are reflected in the RESOLVE-selected resources results
- Modeling portfolios identify only the aggregated amount of gas capacity not retained, but individual locations need to be identified for the TPP studies.
- In identifying which units to model as offline, methodology includes a scoring criteria based on the factors below to develop a prioritized ranking of plants to model as not retained.
  1. Proximity to Disadvantaged communities (DACs): Units in or near a DAC receive higher score.
  2. Emission info and non-attainment zones: Units in Ozone and PM2.5 non-attainment areas receive higher score and units with higher per MWh NOx and SO2 emissions per available EIA data receive higher score.
  3. Age of plant: Older units receive higher score.
  4. Heat Rate: Plants with highest heat rate (by plant type) receive highest score/priority.
  5. CAISO LCR study info: Units with lower effectiveness factors receive higher score.
- In these selections, the CPUC is seeking to identify transmission needs and impacts of potential plant retirements. The CPUC is not directing specific gas generators to retire via these studies.

# Land-use and Environmental Impacts Criteria Analysis

- Land use screens are applied to identified areas that have:
  - Less impact on conservation priorities and alternative land-use activities.
  - Characteristics more favorable for development of the mapped resources.
- For in-state, criteria are based on several CEC-developed screens and existing datasets from other agencies, including:
  - CEC's Core Land-use Screen, CEC Parcelization Model, and CEC Cropland Index Model.
  - Three CDFW's Areas of Conservation Emphasis (ACE) datasets.
  - Conservation Biology Institute's Terrestrial Landscape Intactness and additional datasets
- For out-of-state, in-CAISO resources, CPUC staff utilize the WECC's Environmental Reference Data as a corollary to the Core Land-use Screen analysis criteria.
  - WECC Risk class 2 corresponds to lower implications areas and Risk class 3 corresponds to higher implications areas
  - Other criteria analysis is currently not implemented
- Conducted for solar, on-shore wind, geothermal, and new this cycle, identified potential pumped storage locations.



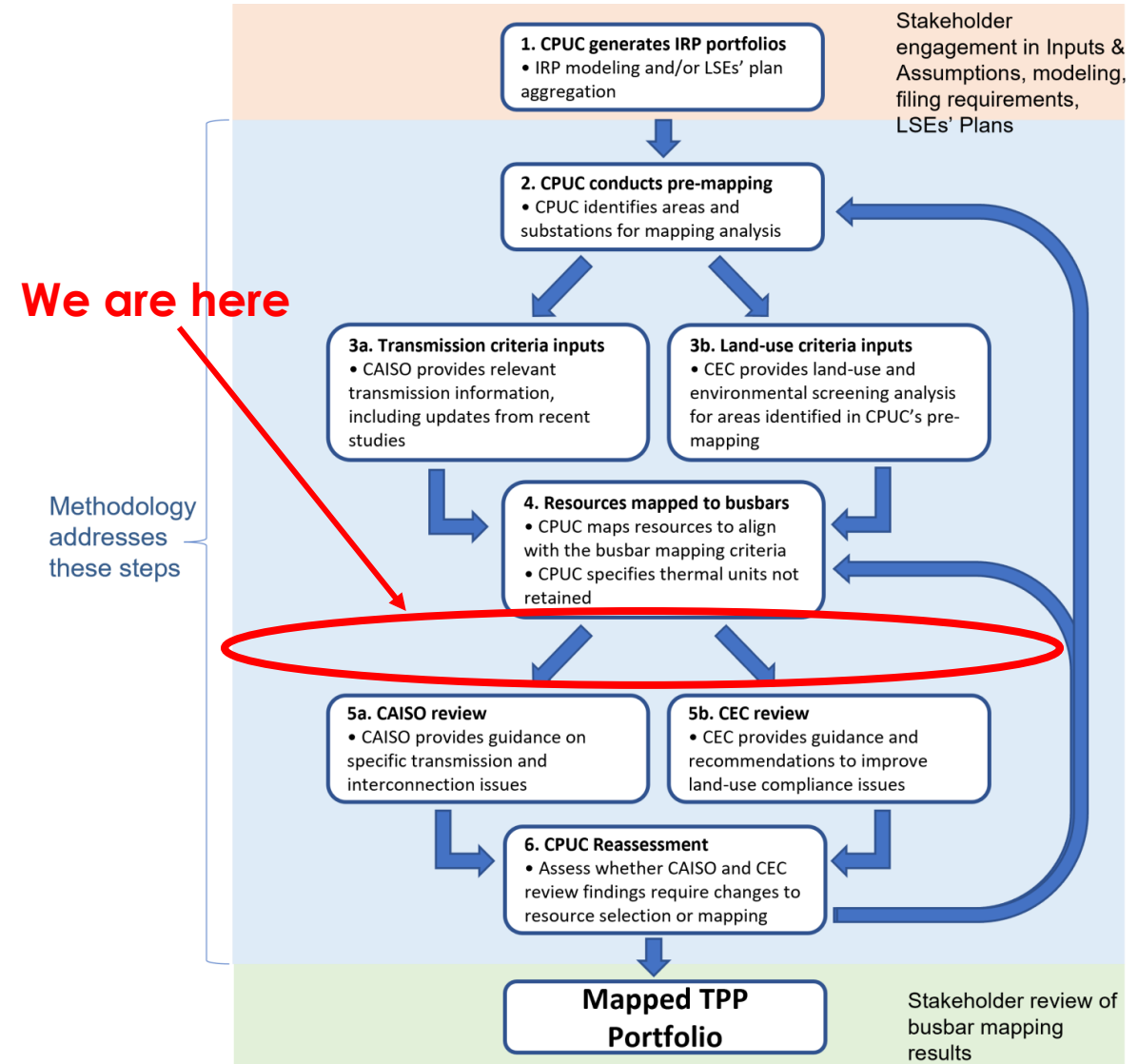
**Above:** Map show solar resource potential assumptions included in the RESOLVE modeling.

# **In-state Land-use and Environmental Analysis (CEC Presentation)**

# Preliminary Mapping Results

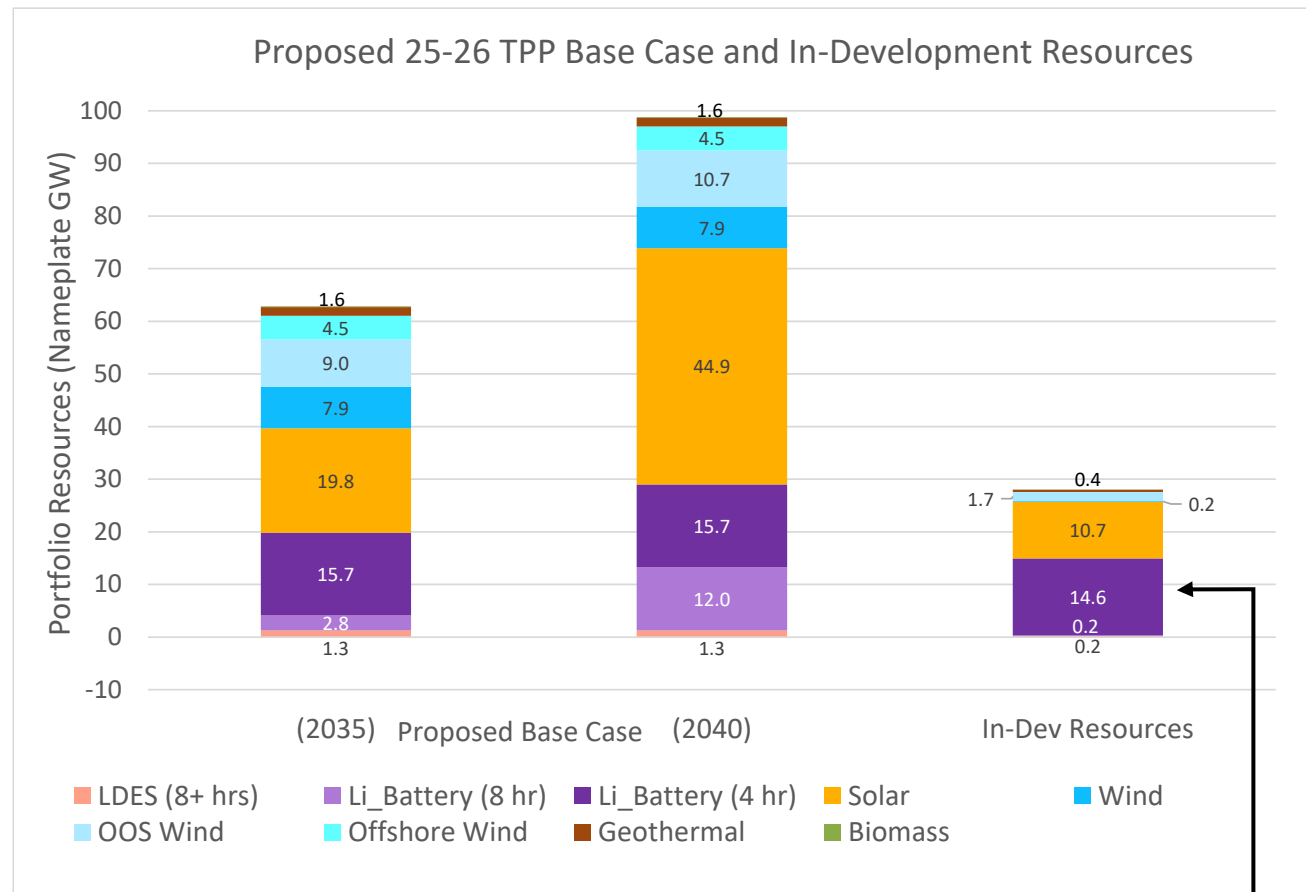
# Preliminary Mapping – Point in the mapping process

- These are first draft mapping results of the base case portfolio
  - These results are undergoing review by the busbar mapping group and typically undergo several rounds of remapping.
- During the review and additional rounds of mapping, staff will work to
  - Assess the locations with non-alignments for potential remapping,
  - Conduct further analysis for interconnection information, commercial interest, environmental impacts, and import details for out-of-state resources,
  - Optimize existing transmission and effective upgrade utilization (including using info from preliminary 24-25 TPP results), and
  - Incorporate stakeholder feedback.
- This section will be a high-level overview of these initial mapping results
  - Full mapping details are in the mapping dashboard at the CPUC webpage: [Assumptions for the 2025-2026 TPP](#)



# Preliminary Mapping – Baseline Reconciliation & In-development Resources

- The proposed portfolios utilize the 2023-PSP modeling baseline.
  - Staff need to reconcile that baseline with the 1/1/2024 online date used for the 2024 White Paper baseline
  - Identify resources that have come online but aren't included in the 2023-PSP baseline.
- Staff identified nearly 28 GW of “In-development resources” not in the IRP modeling baseline that we seek to prioritize mapping alignment.
  - Significant amount of the portfolio storage resources are aligned with the in-development resources



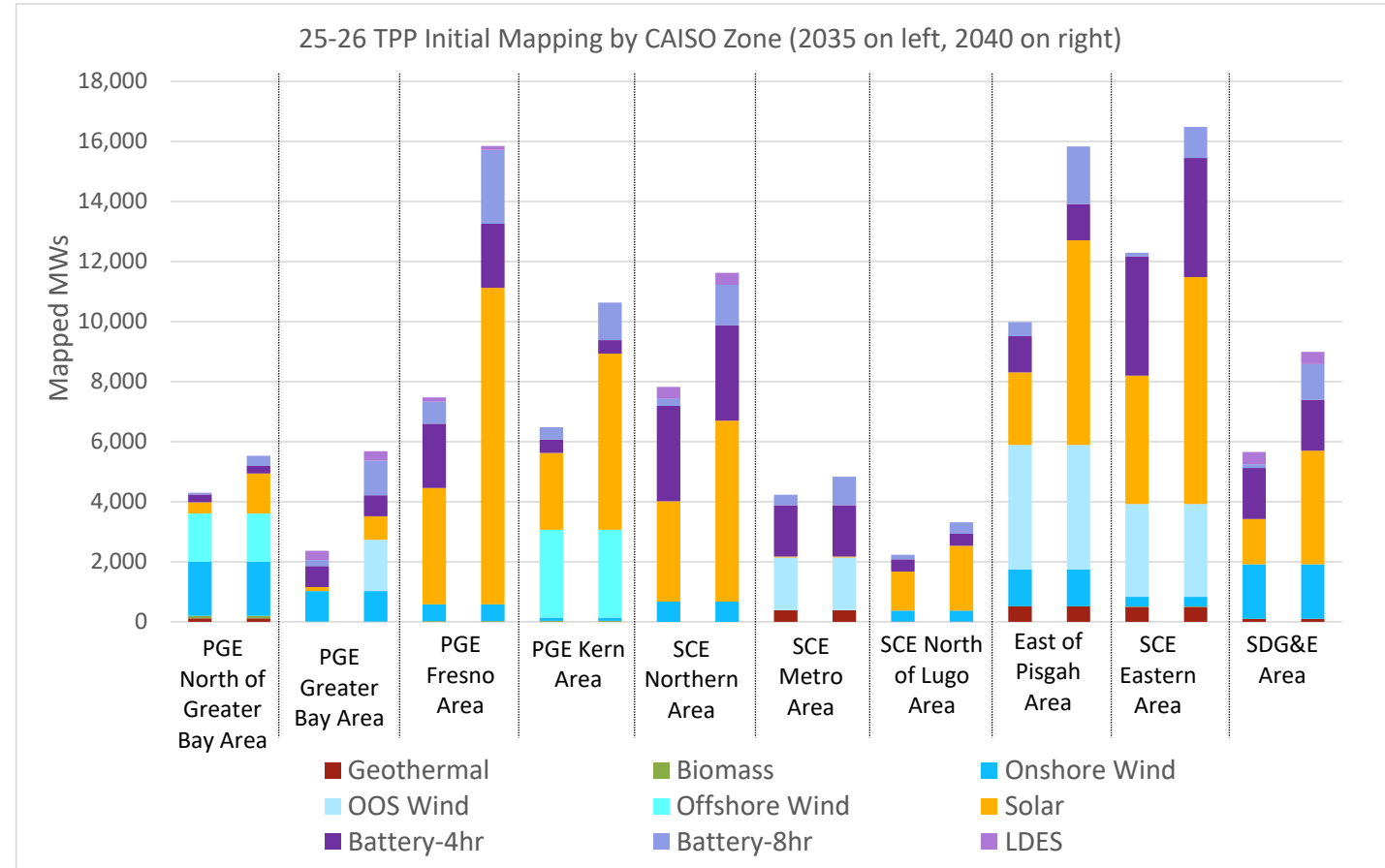
Not included in mapped portfolio, but included in transmission use calculations

	Geothermal (MW)	Biomass (MW)	In-State Wind (MW)	Solar (MW)	4hr - Battery (MW)	8hr - Battery (MW)	Total (MW)
<b>Resources in IRP Baseline (not online by 1/1/2024)</b>	242.0	8.1	76.4	1,202.7	2,612.6	151.0	<b>4,292.8</b>
<b>Resources online by 1/1/2024 (not in IRP Baseline)</b>	-	8.2	-	1,475.5	818.5	-	<b>2,302.2</b>

Included in mapping, but excluded from Tx calculations

# Preliminary Mapping Results Summary by CAISO study area

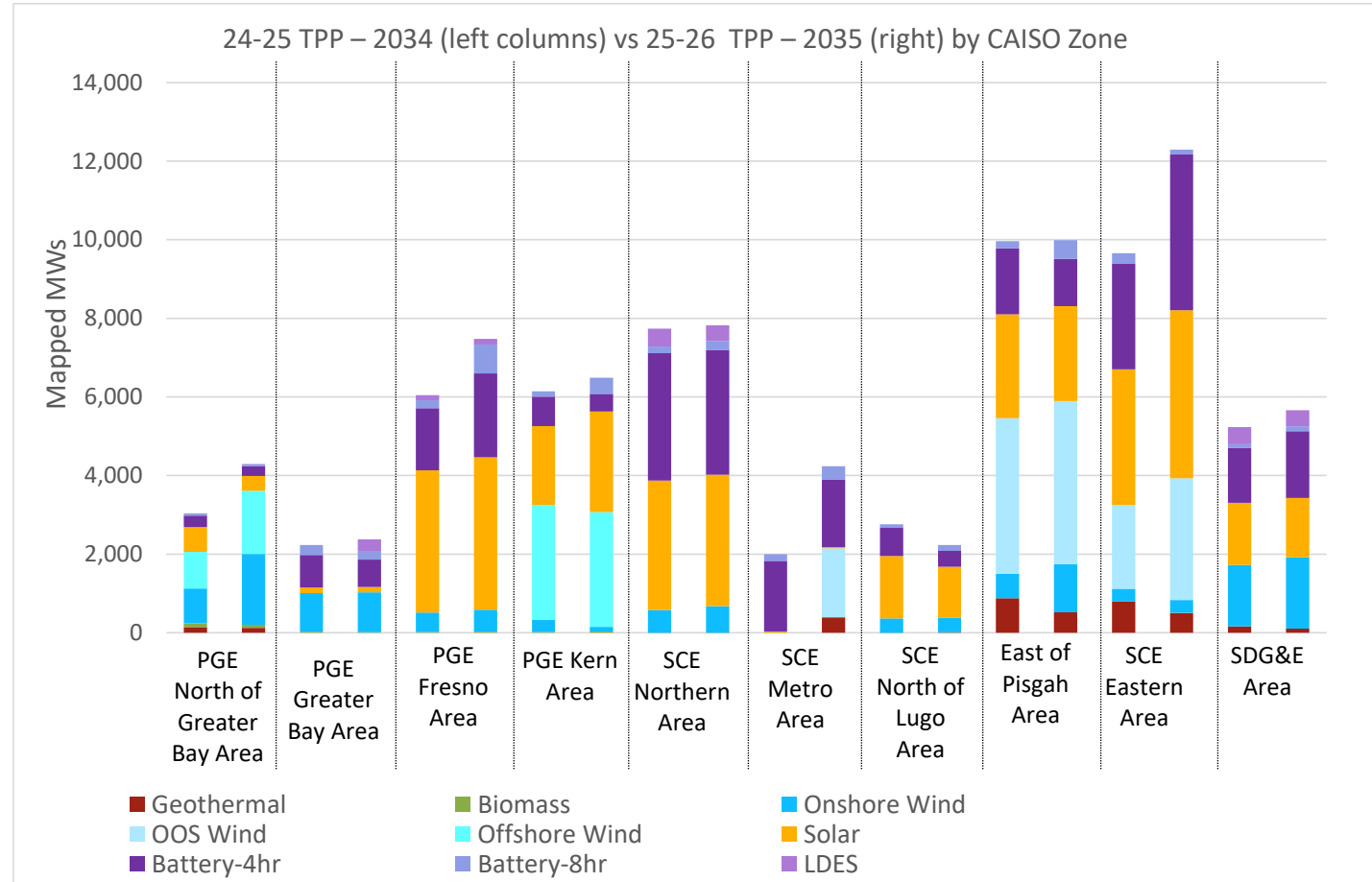
- Chart depicts the 2035 and 2040 initial mapping results by CAISO transmission study area.
- Out-of-CAISO resources are included at the substation nearest to their likely import point
  - Out-of-State wind from Wyoming and Idaho in the East of Pisgah area and in 2040 the PG&E Greater Bay area (Tesla area intertie)
  - New Mexico wind is shown in the SCE Eastern area and the SCE metro area (Lugo intertie point)
  - Imperial geothermal is shown in the SCE eastern and SD&GE areas
  - Northern Nevada and Utah geothermal are shown as interconnecting in the East of Pisgah area and SCE Metro area (reflecting potential use of IPP scheduling points down to Lugo area)



**Left Column for each area is the 2035 amounts; Right Column is the 2040 amounts.**

# Preliminary Mapping Proposed Base Case (2035): Consistency with 24-25 TPP Base Case (2034)

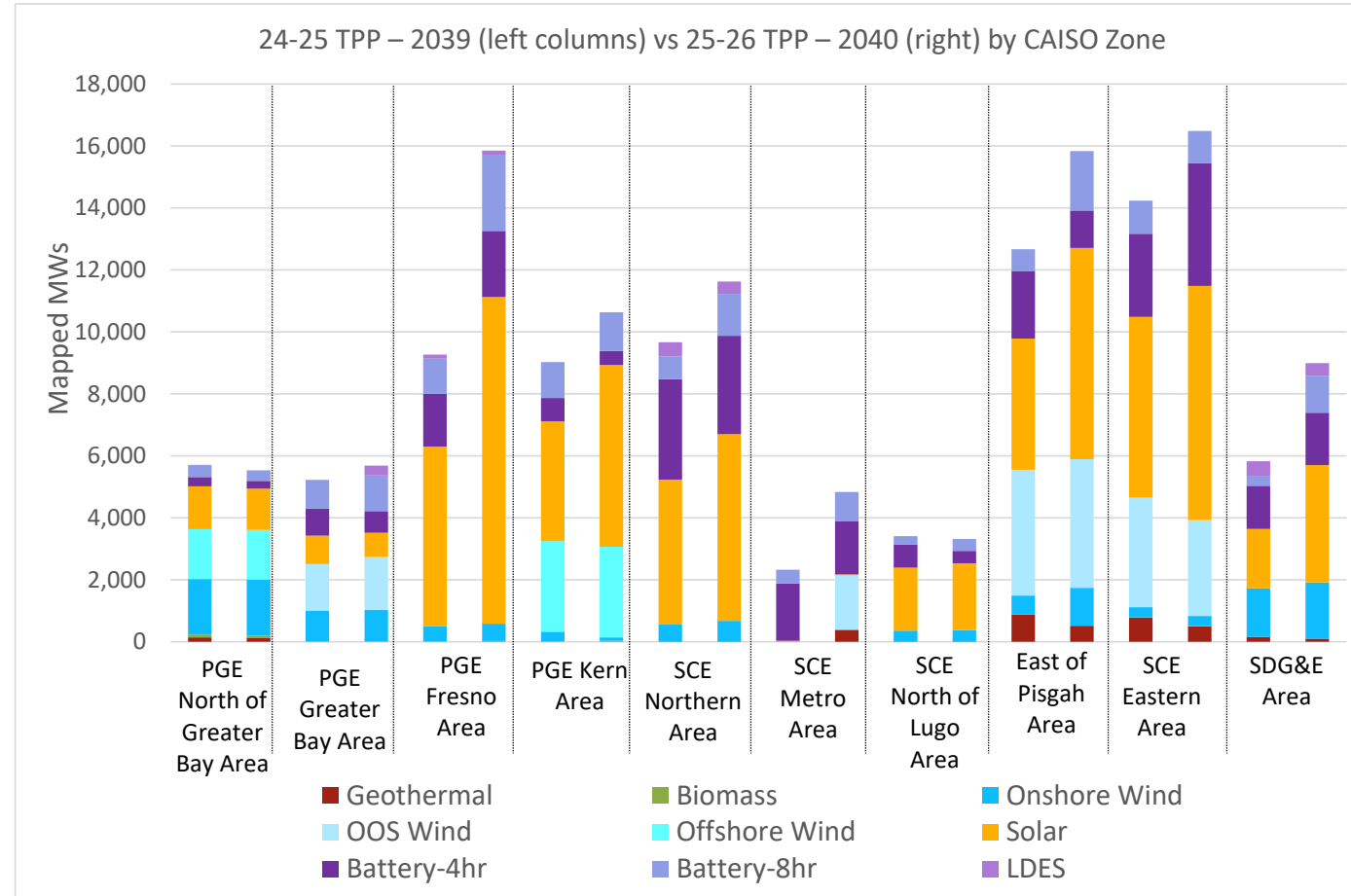
- Chart depicts the 2035 mapping results by CAISO transmission study zone compared to the 24-25 TPP (2034) mapped resources.
- 2035 portfolio size is ~63 GW, compared to ~51 GW in 24-25 TPP base case's 2034 portfolio.
- Nearly all regions have the same or more resources mapped.
  - Slightly less solar & storage in the North of Lugo area.
  - Increase in solar and storage mapped to the PG&E Fresno area
  - Increase in on-shore wind mapped to PG&E North of GB area
  - Increase in SCE Eastern area with additional OOS wind, solar, and storage
  - Increase in OOS wind and geothermal in SCE Metro area (reflects New Mexico wind tying in at Lugo and Utah geothermal utilizing IPP)



**Left Column for each area is the 24-25 TPP (2034) amounts; Right Column is the initial 25-26 TPP (2035) amounts.**

# Preliminary Mapping Proposed Base Case (2040): Consistency with 24-25 TPP Base Case (2039)

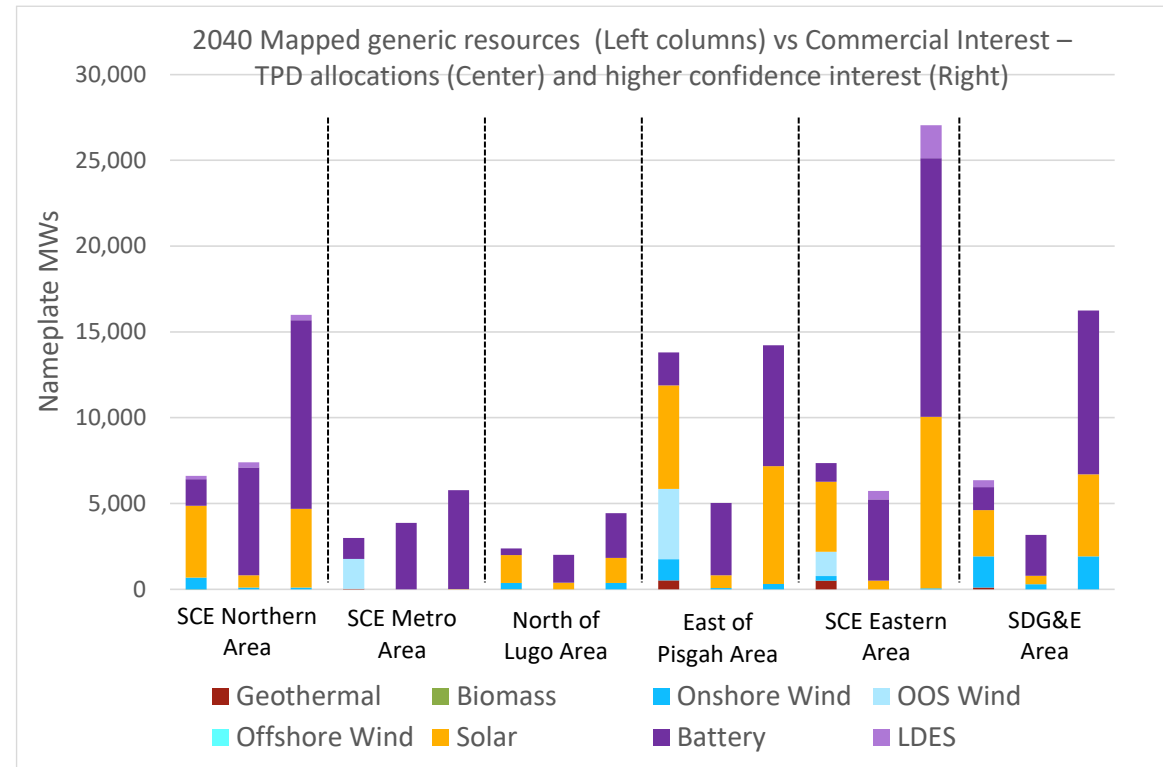
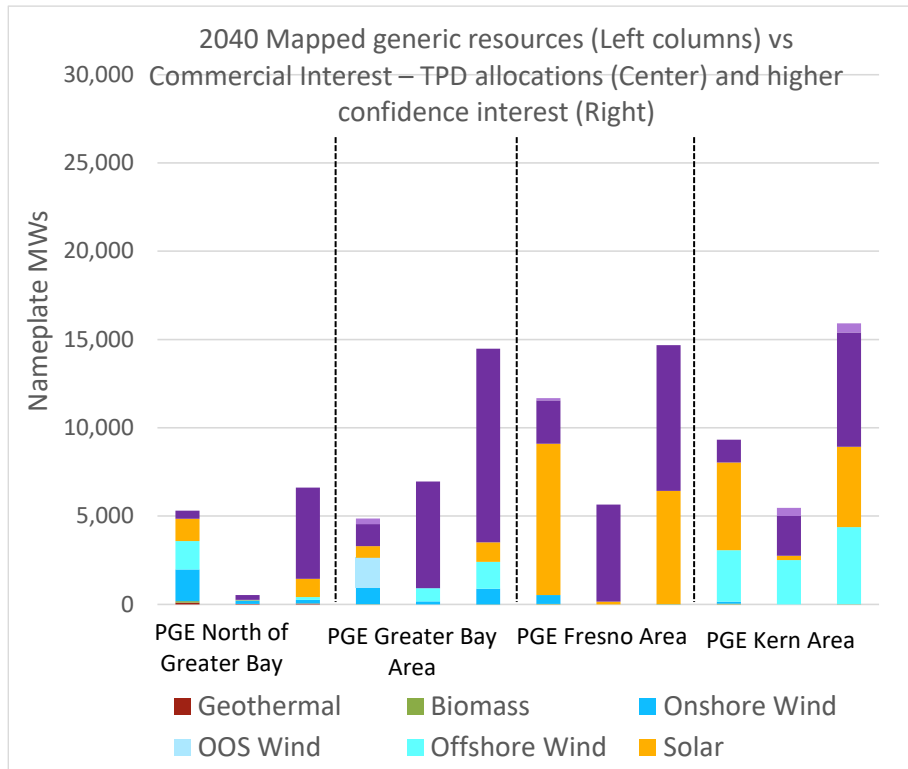
- Chart depicts the 2040 mapping results by CAISO transmission study zone compared to the 24-25 TPP (2039) mapped resources.
- 2040 portfolio size is ~99 GW, compared to ~77 GW in 24-25 TPP base case's 2039 portfolio.
- Nearly all regions have the same or more resources mapped.
  - Only PG&E North of GB Area and SCE North of Lugo areas have slight reductions of solar/storage
  - Large increases in solar and storage in Fresno, East of Pisgah and SCE Eastern areas due to significantly more solar in portfolio
  - Reductions in geothermal mapped to East of Pisgah and SCE Eastern areas reflect less geothermal in portfolio overall and shift of geothermal to other areas in line with in-development resources.



**Left Column for each area is the 24-25 TPP (2039) amounts; Right Column is the initial 25-26 TPP (2040) amounts.**

# Commercial Development Interest Alignment

- Chart below show the 2040 mapped generic resources by CAISO study area compared to higher confidence commercial interest (including transmission plan deliverability (TPD) allocated interest)
  - Key divergence with commercial interest in nearly all regions is large amount of storage (high confidence interest) compared to amount in the portfolio and mapped.
  - Whereas there is less wind and geothermal in the interconnection queues than in the portfolio.



# Environmental Community Impacts

- Chart depicts the 2040 mapping results by CAISO transmission study zone alignment with the Societal and community environmental impacts criteria.

Initial 2040 Portfolio Mapping	In Non-Attainment Zone (O3 or PM2.5)		Substation Near Fossil Fuel Plant (<1 mile)		Substation Near Fossil Fuel Plant (<5 mile)		In IRA Energy Community		In DAC		In or near (<5 mi) DAC	
	Generation	Storage	Generation	Storage	Generation	Storage	Generation	Storage	Generation	Storage	Generation	Storage
<b>Total MWs by Criteria</b>												
PG&E North of Greater Bay Study Area	359	186	1,035	200	1,050	200	2,541	380	113	-	300	38
PG&E Greater Bay Study Area	3,410	1,751	3	945	2,841	1,358	3,349	788	601	308	3,909	1,698
PG&E Fresno Study Area	11,124	4,732	1,573	740	3,903	1,507	47	161	11,086	4,662	22,208	9,394
PG&E Kern Study Area	5,888	1,701	1	-	153	43	4,146	1,133	5,571	1,648	11,459	3,349
SCE Northern Area	6,698	4,860	-	-	322	400	6,700	4,930	753	765	4,660	2,885
SCE Metro Study Area	2,177	2,662	20	882	36	2,480	2,177	2,662	35	2,435	2,213	5,097
SCE North of Lugo Study Area	2,492	756	-	-	662	231	2,535	781	1,115	381	2,360	781
East of Pisgah Study Area	500	150	-	-	3,168	529	12,708	3,125	-	-	-	200
SCE Eastern Study Area	4,911	1,981	605	400	772	1,801	7,786	4,879	163	530	330	1,996
SDG&E Study Area	4,225	2,599	-	412	843	1,332	1,981	1,584	843	828	2,386	1,900
<b>Total</b>	<b>41,784</b>	<b>21,377</b>	<b>3,237</b>	<b>3,579</b>	<b>13,749</b>	<b>9,879</b>	<b>43,969</b>	<b>20,422</b>	<b>20,281</b>	<b>11,556</b>	<b>49,825</b>	<b>27,337</b>

- Initial mapping has ~3.6 GW of storage within 1 mile of a fossil fuel plant and ~11.5 GW of storage within disadvantaged communities.
- For initial biomass mapping, have over a quarter of resources mapped in a disadvantaged community, mostly due to alignment with identified commercial interest.
  - Further mapping rounds will seek to improve alignment for this criteria.

Biomass/gas Alignment			
MWs Mapped	>5 miles	<5 miles	Within
	Proximity to Disadvantaged Communities	98.4	25.6
	<b>Out</b>	<b>In</b>	
PM 2.5 Non-Attainment Zone	117.9	53.2	
Ozone Non-Attainment Zone	88.3	82.7	

# Land-Use and Env. Impacts Alignment – Solar Resources

- Chart depicts the 2040 mapping results for utility-scale solar by CAISO transmission study zone alignment with the Core Land-use Screen and other land-use criteria.
  - For OOS resources only the Core Land-Use Screen is available using the WECC dataset rather than the Core Screen, thus total numbers in certain areas may not add up to the full amount mapped.
  - Additionally, amounts include baseline resources included in calculations and excluded likely repowered resources.

Initial 2040 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Parcelization Criteria Alignment - Highest Flag				Cropland Index Criteria Alignment - Highest Flag				Overdrafted Groundwater		Fire Threat Criteria Alignment - Highest Flag			
	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	In	Out	1 or 2	3	4	5
<b>Solar</b>																		
PG&E N. of Greater Bay	1,285	-	-	-	1,260	25	-	-	1,185	100	-	-	-	1,285	1,285	-	-	-
PG&E Greater Bay	350	-	400	-	750	-	-	-	350	400	-	-	-	750	600	150	-	-
PG&E Fresno Study	9,652	-	-	-	9,652	-	-	-	4,032	5,620	-	-	9,652	-	9,652	-	-	-
PG&E Kern	5,610	-	-	-	5,610	-	-	-	3,675	1,935	-	-	5,219	391	5,519	-	-	91
SCE Northern	5,721	105	-	-	1,005	200	2,008	2,613	5,826	-	-	-	950	4,876	4,050	350	-	1,426
SCE Metro	-	-	10	-	-	-	-	10	10	-	-	-	-	10	10	-	-	-
SCE North of Lugo	1,731	-	-	329	450	200	-	1,410	2,060	-	-	-	32	2,028	2,060	-	-	-
East of Pisgah	6,511	300	-	-	-	-	-	-	-	-	-	-	-	6,811	-	-	-	-
SCE Eastern	6,165	-	1,389	-	3,249	-	100	280	1,929	-	-	1,700	-	7,554	3,629	-	-	-
SDG&E Area	3,771	-	-	-	1,592	-	-	-	892	700	-	-	-	3,771	1,442	90	-	60
<b>Total:</b>	<b>40,795</b>	<b>405</b>	<b>1,799</b>	<b>329</b>	<b>23,568</b>	<b>425</b>	<b>2,108</b>	<b>4,312</b>	<b>19,958</b>	<b>8,755</b>	<b>-</b>	<b>1,700</b>	<b>15,853</b>	<b>27,474</b>	<b>28,245</b>	<b>590</b>	<b>-</b>	<b>1,577</b>

# Environmental Impacts Alignment – Solar Resources

- Chart depicts the 2040 mapping results by CAISO transmission study zone alignment with the various Environmental (Conservation and Biodiversity) criteria.
  - For OOS resources these criteria cannot currently be applied.

Initial 2040 Portfolio Mapping	ACE Connectivity Criteria Alignment - Highest Flag				ACE Biodiversity Criteria Alignment - Highest Flag				ACE Irreplaceability Criteria Alignment - Highest Flag				All ACE Criteria Alignment - Highest Flag				Intactness Criteria Alignment - Highest Flag				Wetlands Criteria Alignment - Highest Flag			
	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
<b>Solar</b>																								
PG&E N. of Greater Bay	1,272	13	-	-	1,285	-	-	-	1,285	-	-	-	1,117	168	-	-	1,285	-	-	-	1,285	-	-	-
PG&E Greater Bay	350	400	-	-	750	-	-	-	650	100	-	-	250	500	-	-	750	-	-	-	750	-	-	-
PG&E Fresno Study	9,652	-	-	-	9,652	-	-	-	9,652	-	-	-	8,252	1,400	-	-	9,652	-	-	-	9,652	-	-	-
PG&E Kern	5,610	-	-	-	5,610	-	-	-	5,607	3	-	-	4,517	1,090	3	-	5,610	-	-	-	5,610	-	-	-
SCE Northern	5,826	-	-	-	5,826	-	-	-	5,826	-	-	-	5,476	350	-	-	5,826	-	-	-	5,826	-	-	-
SCE Metro	10	-	-	-	10	-	-	-	-	-	-	10	-	-	-	10	10	-	-	-	-	-	10	-
SCE North of Lugo	1,531	200	329	-	2,060	-	-	-	2,060	-	-	-	1,531	200	-	329	2,060	-	-	-	1,731	-	329	-
East of Pisgah	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern	2,240	1,389	-	-	3,629	-	-	-	3,629	-	-	-	2,240	1,389	-	-	3,629	-	-	-	2,240	1,389	-	-
SDG&E Area	1,592	-	-	-	1,592	-	-	-	1,592	-	-	-	1,592	-	-	-	1,592	-	-	-	1,592	-	-	-
<b>Total:</b>	<b>28,082</b>	<b>2,002</b>	<b>329</b>	<b>-</b>	<b>30,413</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>30,300</b>	<b>103</b>	<b>-</b>	<b>10</b>	<b>24,974</b>	<b>5,096</b>	<b>3</b>	<b>339</b>	<b>30,413</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>28,685</b>	<b>1,389</b>	<b>339</b>	<b>-</b>

- Key land-use and environmental impacts alignment areas for further analysis and potential remapping.
  - North of Lugo area: predominately Kramer substation but also Coolwater for core land-use screen and connectivity criteria
  - SCE Eastern area: Red Bluff for core land-use screen and Colorado River for the Cropland criteria
  - SCE Northern area: Tehachapi area substations for parcelization and fire threat criteria

# Land-Use and Env. Impacts Alignment – Wind Resources

- Chart depicts the 2040 mapping results by CAISO transmission study zone alignment with the various Land-use and Environmental Impacts criteria.
  - For OOS resources only the Core Land-Use Screen is available (no data for wind mapped to Baja California, MX).
  - Additionally, Parcelization and Cropland criteria are not applied for wind or geothermal.

• Key areas of further focus and potential mapping adjustments:

- SDG&E Area: Wind mapped to Boulevard East and the Ocotillio-Suncrest line for Core Screen and fire threat criteria.
- Northern California areas: multiple substations for Core Screen, Fire threat, and Intactness criteria.

Initial 2040 Portfolio Mapping	Core Land-use Screen Criteria Alignment				Fire Threat Criteria Alignment - Highest Flag				Intactness Criteria Alignment - Highest Flag				Wetlands Criteria Alignment - Highest Flag			
	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
Onshore Wind																
PG&E N. of Greater Bay	859	-	944	-	466	-	-	1,337	747	1,056	-	-	1,559	-	244	-
PG&E Greater Bay	109	-	551	-	660	-	-	-	660	-	-	-	660	-	-	-
PG&E Fresno Study	500	-	-	-	500	-	-	-	500	-	-	-	500	-	-	-
PG&E Kern	113	-	91	-	-	-	-	204	204	-	-	-	204	-	-	-
SCE Northern	500	-	174	-	474	-	-	200	674	-	-	-	500	174	-	-
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE North of Lugo	362	-	-	-	362	-	-	-	362	-	-	-	362	-	-	-
East of Pisgah	1,229	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern	-	235	-	-	-	-	-	235	235	-	-	-	235	-	-	-
SDG&E Area	63	-	400	-	-	-	-	463	463	-	-	-	463	-	-	-
<b>Total:</b>	<b>3,735</b>	<b>235</b>	<b>2,160</b>	<b>-</b>	<b>2,462</b>	<b>-</b>	<b>-</b>	<b>2,439</b>	<b>3,845</b>	<b>1,056</b>	<b>-</b>	<b>-</b>	<b>4,483</b>	<b>174</b>	<b>244</b>	<b>-</b>

Initial 2040 Portfolio Mapping	ACE Connectivity Criteria Alignment - Highest Flag				ACE Biodiversity Criteria Alignment - Highest Flag				ACE Irreplaceability Criteria Alignment - Highest Flag				All ACE Criteria Alignment - Highest Flag			
	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5	1 or 2	3	4	5
Onshore Wind																
PG&E N. of Greater Bay	1,690	113	-	-	1,803	-	-	-	1,672	131	-	-	1,559	-	-	244
PG&E Greater Bay	660	-	-	-	660	-	-	-	660	-	-	-	660	-	-	-
PG&E Fresno Study	390	110	-	-	500	-	-	-	500	-	-	-	390	110	-	-
PG&E Kern	204	-	-	-	204	-	-	-	204	-	-	-	113	91	-	-
SCE Northern	674	-	-	-	674	-	-	-	674	-	-	-	500	174	-	-
SCE Metro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE North of Lugo	362	-	-	-	362	-	-	-	362	-	-	-	362	-	-	-
East of Pisgah	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCE Eastern	235	-	-	-	235	-	-	-	235	-	-	-	235	-	-	-
SDG&E Area	463	-	-	-	463	-	-	-	463	-	-	-	463	-	-	-
<b>Total:</b>	<b>4,678</b>	<b>223</b>	<b>-</b>	<b>-</b>	<b>4,901</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>4,770</b>	<b>131</b>	<b>-</b>	<b>-</b>	<b>4,282</b>	<b>375</b>	<b>-</b>	<b>244</b>

# Transmission Constraint Exceedances Impacts (2035)

- Chart depicts the CAISO Tx constraint exceedances calculated from the 2035 initial mapping.
  - 10 actual & 1 default exceedances
- For comparison, RESOLVE modelling triggered 3 new partial transmission upgrades.
- Key areas of exceedances:
  - Northern CA and Greater Bay Areas
  - Northern Central Valley
  - Areas of key out-of-CAISO import areas: SCE Eastern area connection to IID and North of Lugo area
- Several exceedances triggered with in-development resources.
- Does not include out-of-CAISO transmission that would be needed to bring resources to existing CAISO intertie points.

Base Case (2035) Tx Constraint Exceedances		Constraint's Capability per White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculate d Largest On-peak Exceedance	Calculate d Off-peak Exceedance	White Paper Upgrade Info	
CAISO Zone	Constraint Name	On-Peak (MW)	Off-Peak (MW)	Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capabili ty Increase (MW)	Estimate d Cost (millions )
PG&E North of Greater Bay	Carberry-Round Mountain 230kV Line	15	15	200	-	-	17	6	-	(102)	(115)	26	\$ 180
	Bellota-Weber 230kV Line	1,661	2,539	411	311	2,059	90	93	775	(429)	None	460	\$ 400
PG&E Greater Bay	Windmaster-Delta pumps 230 kV Line	546	3,673	416	25	1,023	15	187	137	(763)	None	6,034	\$ 417
	Birds Landing-Contra Costa 230kV Line	656	1,176	333	75	533	165	140	269	(219)	None	1,766	\$ 700
PG&E Fresno	Chowchilla-Le grand 115kV Line	-	158	320	-	448	9	70	39	(617)	None	1,211	\$ 550
	Borden-Storey #1 230kV line	412	780	320	330	1,251	22	70	886	(1,070)	None	1,247	\$ 50
SCE North of Lugo	Control to Inyokern Area	-	120	-	-	-	13	-	-	(13)	None	186	\$ 329
	South of Kramer Area	456	1,190	100	321	352	15	112	400	(8)	None	N/A	N/A
SCE Eastern	Eagle Mountain Constraint	-	392	-	-	410	525	-	390	(935)	(23)	600	\$ 1,182
East of Pisgah	Lugo-Victorville Area	10,105	12,605	8,358	1,806	4,330	602	371	3,794	(499)	None	6,800	\$ 2,165
SDG&E	Chicarita 138 kV	224	224	-	-	310	-	-	-	(86)	None	700	\$ 100

\*\* Includes amounts from IRP baseline resources not in the White Paper baseline cutoff date

# Transmission Constraint Exceedances Impacts (2040)

- Chart depicts the Tx constraint exceedances calculated from the 2040 initial mapping.
  - 18 actual & 3 default exceedances
- For comparison, RESOLVE modelling triggered 8 new full or partial transmission upgrades
- 2040 mapping increases the exceedances of the 2035 results and expands the number exceedances particularly in the PG&E Fresno area.
- Exceedances will be further assessed by working group.
  - Small exceedances may not result in upgrades or have resources that likely can be remapped.

Remaining on-peak capability without upgrades with 2040 mapping	Subs with available capacity		Highest remaining capability (MW)
	High Voltage (>200 kV)	Low Voltage (<200 kV)	
PG&E GBA	1	10	900
PG&E Fresno	5	-	2,400
SCE Northern	8	2	2,900
SCE Metro	43	-	9,100
SCE North of Lugo	2	2	200
SCE Eastern	1	-	800
SDG&E	2	6	200

Base Case (2034) Tx Constraint Exceedances		Constraint's White Paper		FCDS Resources Mapped (In-Dev & Generic)**				EODS Resources Mapped**		Calculated Largest On-peak Exceedance	Calculated Off-peak Exceedance	White Paper Upgrade Info	
CAISO Zone	Constraint Name	On-Peak Capability (MW)	Off-Peak Capability (MW)	Onshore & Offshore Wind (MW)	Solar (MW)	Storage (MW)	Biomass & Geothermal (MW)	Onshore Wind (MW)	Solar (MW)			Capacity Increase (MW)	Estimated Cost (millions)
PG&E North of Greater Bay	Carberry-Round Mountain 230kV Line	15	15	200	-	-	17	6	-	(102)	(115)	26	\$ 180
	Bellota-Weber 230kV Line	1,661	2,539	411	861	2,188	90	93	1,785	(951)	None	460	\$ 400
PG&E Greater Bay	Windmaster-Delta pumps 230 kV Line	546	3,673	416	45	1,123	75	187	417	(866)	None	6,034	\$ 417
	Tesla-Bellota 230 kV line	3,154	4,254	2,688	6	2,542	162	256	825	(1,185)	None	300	\$ 1,700
	Birds Landing-Contra Costa 230kV Line	656	1,176	333	330	823	165	140	899	(548)	None	1,766	\$ 700
PG&E Kern	Cal Flat-Gates 230 kV line	927		113	1,078	759	28	-	1,168	(267)	(60)	1,418	\$ 1,008
	Gates 500/230kV TB #11	5,406	3,581	780	3,543	4,373	43	70	6,519	None	(369)	14,825*	\$ 35
PG&E Fresno	Gates 500/230kV TB #11	5,337	5,027	780	3,903	4,330	41	70	7,045	(9)	None	10,038*	\$ 35
	Tranquility-Helm 230kV Line	2,921	2,777	320	1,733	2,792	24	70	3,426	(315)	None	2,274	\$ 1,500
	Chowchilla-Le grand 115kV Line	-	158	320	150	603	9	70	419	(795)	None	1,211	\$ 550
	Schindler 115/70kV TB #1	-	50	-	100	20	-	-	30	(81)	(33)	3,160	\$ 370
	Borden-Storey #1 230kV line	412	780	320	880	1,761	22	70	2,116	(1,663)	None	1,247	\$ 50
	Mustang-Henrietta 230 kV line	5,581	5,617	3,187	3,218	3,285	23	50	5,646	(828)	(1,162)	2,479	\$ 830
SCE North of Lugo	Control to Inyokern Area	-	120	-	-	-	13	-	-	(13)	None	186	\$ 329
	South of Kramer Area	456	1,190	100	321	352	15	112	400	(8)	None	N/A	N/A
	Calcite to Lugo Area	297	552	150	540	335	-	-	599	(328)	(57)	1,046	\$ 239
SCE Eastern	Eagle Mountain Constraint	-	392	-	-	410	525	-	390	(935)	(23)	600	\$ 1,182
	Serrano-Alberhill-Valley Constraint	8,173	10,182	3,637	2,225	5,149	530	37	5,049	(177)	None	N/A	N/A
East of Pisgah	Sloan Canyon - Eldorado 500 kV constraint	4,032	4,302	1,517	2,436	2,685	600	244	3,175	(395)	None	N/A	N/A
	Lugo-Victorville Area	10,105	12,605	8,358	4,756	6,690	602	371	8,214	(3,242)	None	6,800	\$ 2,165
SDG&E	Chicarita 138 kV	224	224	-	-	310	-	-	-	(86)	None	700	\$ 100

\*\* Includes amounts from IRP baseline resources not in the White Paper baseline cutoff date

\*Same upgrade

# Study area focus – North of GB and GB Areas

- Summary of initial mapping to the two Northern California study areas
  - Includes comparison to 24-25 TPP and commercial interest.
- Key mapping issues working group continues to assess:
  - Transmission impacts of offshore wind to the broader study areas and multiple transmission exceedances
  - Wind resources land-use implications
  - Commercial interest alignment for large amount of higher confidence storage
  - Feasibility and transmission needs of over 1 GW of in-state wind mapped to Nevada Energy side of Lassen/Modoc counties
  - Wyoming wind mapped as interconnecting in 2040 to the Tesla area based on [CAISO's 20-year Transmission Outlook](#)'s new transmission line potential solution
  - Generic LDES mapped to proposed pumped storage location

Previous Base Case Comparison									
PG&E North of Greater Bay	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)	PG&E Greater Bay	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)
Geothermal (MW)	123	123	144	144	Geothermal (MW)	-	-	-	-
Biomass (MW)	80	80	94	94	Biomass (MW)	13	13	23	23
OnshoreWind (MW)	1,803	1,803	887	1,787	OnshoreWind (MW)	1,014	1,014	988	988
OOS Wind (MW)	-	-	-	-	OOS Wind (MW)	-	1,707	-	1,500
Offshore Wind (MW)	1,607	1,607	931	1,607	Offshore Wind (MW)	-	-	-	-
Solar (MW)	377	1,332	630	1,390	Solar (MW)	139	789	140	915
Battery-4hr (MW)	251	251	293	293	Battery-4hr (MW)	698	698	829	879
Battery-8hr (MW)	50	335	50	390	Battery-8hr (MW)	200	1,152	250	920
LDES (MW)	5	5	5	5	LDES (MW)	310	310	-	-
<b>Zone Total (MW)</b>	<b>4,296</b>	<b>5,536</b>	<b>3,035</b>	<b>5,712</b>	<b>Zone Total (MW)</b>	<b>2,373</b>	<b>5,683</b>	<b>2,230</b>	<b>5,225</b>

Commercial Interest Comparison									
PG&E North of Greater Bay	Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest	PG&E Greater Bay	Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest
Geothermal (MW)	98	28	37	37	Geothermal (MW)	-	-	-	-
Biomass (MW)	77	-	10	35	Biomass (MW)	10	-	1	5
OnshoreWind (MW)	1,803	200	206	337	OnshoreWind (MW)	923	161	882	1,385
OOS Wind (MW)	-	-	-	-	OOS Wind (MW)	1,707	-	-	-
Offshore Wind (MW)	1,607	-	162	2,462	Offshore Wind (MW)	-	750	1,525	1,525
Distrib. Solar (MW)	30	-	45	91	Distrib. Solar (MW)	33	-	97	180
Solar (MW)	1,260	25	1,030	7,293	Solar (MW)	650	-	1,100	4,357
Battery (MW)	465	270	5,169	15,672	Battery (MW)	1,262	6,048	10,976	72,700
LDES (MW)	-	-	-	482	LDES (MW)	310	-	-	500
<b>Total (MW)</b>	<b>5,339</b>	<b>522</b>	<b>6,660</b>	<b>26,410</b>	<b>Total (MW)</b>	<b>4,895</b>	<b>6,959</b>	<b>14,580</b>	<b>80,653</b>

# Study area focus – PG&E Fresno & Kern Areas

- Summary of initial mapping to the two Central California study areas
  - Includes comparison to 24-25 TPP and commercial interest.
- Key mapping issues working group continues to assess:
  - Multiple transmission exceedances and optimal remapping or transmission upgrade solutions
  - Transmission impacts of mapped central coast offshore wind
  - Commercial interest alignment for large amount of higher confidence storage
  - Interconnection of large amounts of solar and storage mapped to substations

Previous Base Case Comparison									
	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)		Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)
PG&E Fresno					PG&E Kern				
Geothermal (MW)	-	-	-	-	Geothermal (MW)	-	-	-	-
Biomass (MW)	27	27	20	20	Biomass (MW)	33	33	18	18
OnshoreWind (MW)	561	561	490	490	OnshoreWind (MW)	113	113	310	310
OOS Wind (MW)	-	-	-	-	OOS Wind (MW)	-	-	-	-
Offshore Wind (MW)	-	-	-	-	Offshore Wind (MW)	2,924	2,924	2,924	2,924
Solar (MW)	3,877	10,537	3,619	5,795	Solar (MW)	2,559	5,869	2,005	3,870
Battery-4hr (MW)	2,137	2,137	1,584	1,699	Battery-4hr (MW)	451	451	747	747
Battery-8hr (MW)	735	2,455	200	1,132	Battery-8hr (MW)	410	1,250	142	1,157
LDES (MW)	140	140	130	130	LDES (MW)	-	-	-	-
<b>Zone Total (MW)</b>	<b>7,476</b>	<b>15,856</b>	<b>6,044</b>	<b>9,266</b>	<b>Zone Total (MW)</b>	<b>6,490</b>	<b>10,640</b>	<b>6,146</b>	<b>9,026</b>
Commercial Interest Comparison									
	Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest		Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest
PG&E Fresno					PG&E Kern				
Geothermal (MW)	-	-	-	-	Geothermal (MW)	-	-	-	-
Biomass (MW)	25	-	12	12	Biomass (MW)	33	-	6	20
OnshoreWind (MW)	500	-	4	204	OnshoreWind (MW)	113	-	-	-
OOS Wind (MW)	-	-	-	-	OOS Wind (MW)	-	-	-	-
Offshore Wind (MW)	-	-	-	-	Offshore Wind (MW)	2,924	2,500	4,366	7,726
Distrib. Solar (MW)	29	-	61	100	Distrib. Solar (MW)	32	-	84	160
Solar (MW)	8,572	146	6,416	33,044	Solar (MW)	4,956	246	4,554	15,958
Battery (MW)	2,447	5,508	8,249	46,583	Battery (MW)	1,300	2,254	6,472	21,495
LDES (MW)	140	-	-	119	LDES (MW)	-	465	520	520
<b>Total (MW)</b>	<b>11,712</b>	<b>5,654</b>	<b>14,741</b>	<b>80,061</b>	<b>Total (MW)</b>	<b>9,357</b>	<b>5,464</b>	<b>16,003</b>	<b>45,879</b>

# Study area focus – SCE Northern & Metro Areas

- Summary of initial mapping to the SCE Northern and Metro study areas
  - Includes comparison to 24-25 TPP and commercial interest.
- Key mapping issues working group continues to assess:
  - Mapping of in-development Utah and Nevada geothermal to Lugo and assumed to be using IPP scheduling rights
  - New Mexico wind mapped as interconnecting to the Lugo substation based on the 20-year outlook new transmission potential solution
  - Mapping of stand-alone storage in the LA Basin LCR area and alignment with community impacts criteria
  - Commercial interest alignment for large amount of higher confidence storage
  - Interconnection of large amounts of solar and storage mapped to substations in the Tehachapi area

Previous Base Case Comparison									
	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)		Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)
SCE Northern Area					SCE Metro				
Geothermal (MW)	-	-	-	-	Geothermal (MW)	389	389	-	-
Biomass (MW)	2	2	1	1	Biomass (MW)	6	6	6	6
OnshoreWind (MW)	674	674	580	580	OnshoreWind (MW)	-	-	-	-
OOS Wind (MW)	-	-	-	-	OOS Wind (MW)	1,750	1,750	-	-
Offshore Wind (MW)	-	-	-	-	Offshore Wind (MW)	-	-	-	-
Solar (MW)	3,344	6,024	3,291	4,656	Solar (MW)	33	33	27	34
Battery-4hr (MW)	3,179	3,179	3,240	3,240	Battery-4hr (MW)	1,712	1,712	1,795	1,845
Battery-8hr (MW)	226	1,351	170	734	Battery-8hr (MW)	350	950	167	447
LDES (MW)	400	400	458	458	LDES (MW)	-	-	-	-
<b>Zone Total (MW)</b>	<b>7,825</b>	<b>11,630</b>	<b>7,739</b>	<b>9,669</b>	<b>Zone Total (MW)</b>	<b>4,239</b>	<b>4,839</b>	<b>1,994</b>	<b>2,331</b>

Commercial Interest Comparison									
	Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest		Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest
SCE Northern Area					SCE Metro				
Geothermal (MW)	-	-	-	-	Geothermal (MW)	23	-	-	80
Biomass (MW)	2	-	-	-	Biomass (MW)	-	-	-	-
OnshoreWind (MW)	674	100	100	229	OnshoreWind (MW)	-	-	-	-
OOS Wind (MW)	-	-	-	-	OOS Wind (MW)	1,750	-	-	-
Offshore Wind (MW)	-	-	-	-	Offshore Wind (MW)	-	-	-	-
Distrib. Solar (MW)	-	-	-	39	Distrib. Solar (MW)	-	-	-	-
Solar (MW)	4,190	710	4,586	11,544	Solar (MW)	-	-	10	10
Battery (MW)	1,545	6,287	11,003	27,165	Battery (MW)	1,223	3,861	5,764	19,684
LDES (MW)	200	300	312	812	LDES (MW)	-	-	-	-
<b>Total (MW)</b>	<b>6,611</b>	<b>7,397</b>	<b>16,000</b>	<b>39,790</b>	<b>Total (MW)</b>	<b>2,996</b>	<b>3,861</b>	<b>5,774</b>	<b>19,774</b>

# Study area focus – North of Lugo & East of Pisgah Areas

- Summary of initial mapping to the North of Lugo and East of Pisgah areas
  - Includes comparison to 24-25 TPP and commercial interest.
- Key mapping issues working group continues to assess:
  - Land-use implications in both areas for solar
  - Transmission exceedances in both areas
  - Mapping CAISO intertie locations for Central and Northern Nevada geothermal
  - 3 GW of Wyoming wind mapped as interconnecting to the Eldorado or Harry Allen
  - 1.1 GW of Idaho wind mapped to Harry Allen

Previous Base Case Comparison									
	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)		Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)
SCE North of Lugo					East of Pisgah				
Geothermal (MW)	10	10	-	-	Geothermal (MW)	517	517	875	875
Biomass (MW)	4	4	2	2	Biomass (MW)	-	-	-	-
OnshoreWind (MW)	362	362	360	360	OnshoreWind (MW)	1,229	1,229	620	620
OOS Wind (MW)	-	-	-	-	OOS Wind (MW)	4,151	4,151	3,965	4,060
Offshore Wind (MW)	-	-	-	-	Offshore Wind (MW)	-	-	-	-
Solar (MW)	1,305	2,159	1,593	2,037	Solar (MW)	2,411	6,811	2,640	4,230
Battery-4hr (MW)	403	403	716	746	Battery-4hr (MW)	1,210	1,210	1,684	2,188
Battery-8hr (MW)	148	378	90	265	Battery-8hr (MW)	470	1,915	180	696
LDES (MW)	-	-	-	-	LDES (MW)	-	-	-	-
<b>Zone Total (MW)</b>	<b>2,232</b>	<b>3,316</b>	<b>2,761</b>	<b>3,410</b>	<b>Zone Total (MW)</b>	<b>9,988</b>	<b>15,833</b>	<b>9,964</b>	<b>12,669</b>

Commercial Interest Comparison									
	Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest		Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest
SCE North of Lugo					East of Pisgah				
Geothermal (MW)	-	-	-	5	Geothermal (MW)	517	-	-	968
Biomass (MW)	4	-	-	3	Biomass (MW)	-	-	-	-
OnshoreWind (MW)	362	-	362	462	OnshoreWind (MW)	1,229	66	310	1,418
OOS Wind (MW)	-	-	-	-	OOS Wind (MW)	4,100	-	-	11,478
Offshore Wind (MW)	-	-	-	-	Offshore Wind (MW)	-	-	-	-
Distrib. Solar (MW)	7	-	13	52	Distrib. Solar (MW)	-	-	-	-
Solar (MW)	1,620	381	1,470	9,738	Solar (MW)	6,036	741	6,865	21,980
Battery (MW)	397	1,618	2,601	18,477	Battery (MW)	1,915	4,224	7,043	27,143
LDES (MW)	-	-	-	500	LDES (MW)	-	-	-	500
<b>Total (MW)</b>	<b>2,390</b>	<b>1,999</b>	<b>4,447</b>	<b>29,237</b>	<b>Total (MW)</b>	<b>13,797</b>	<b>5,031</b>	<b>14,218</b>	<b>63,486</b>

# Study area focus – SCE Eastern and SDG&E Areas

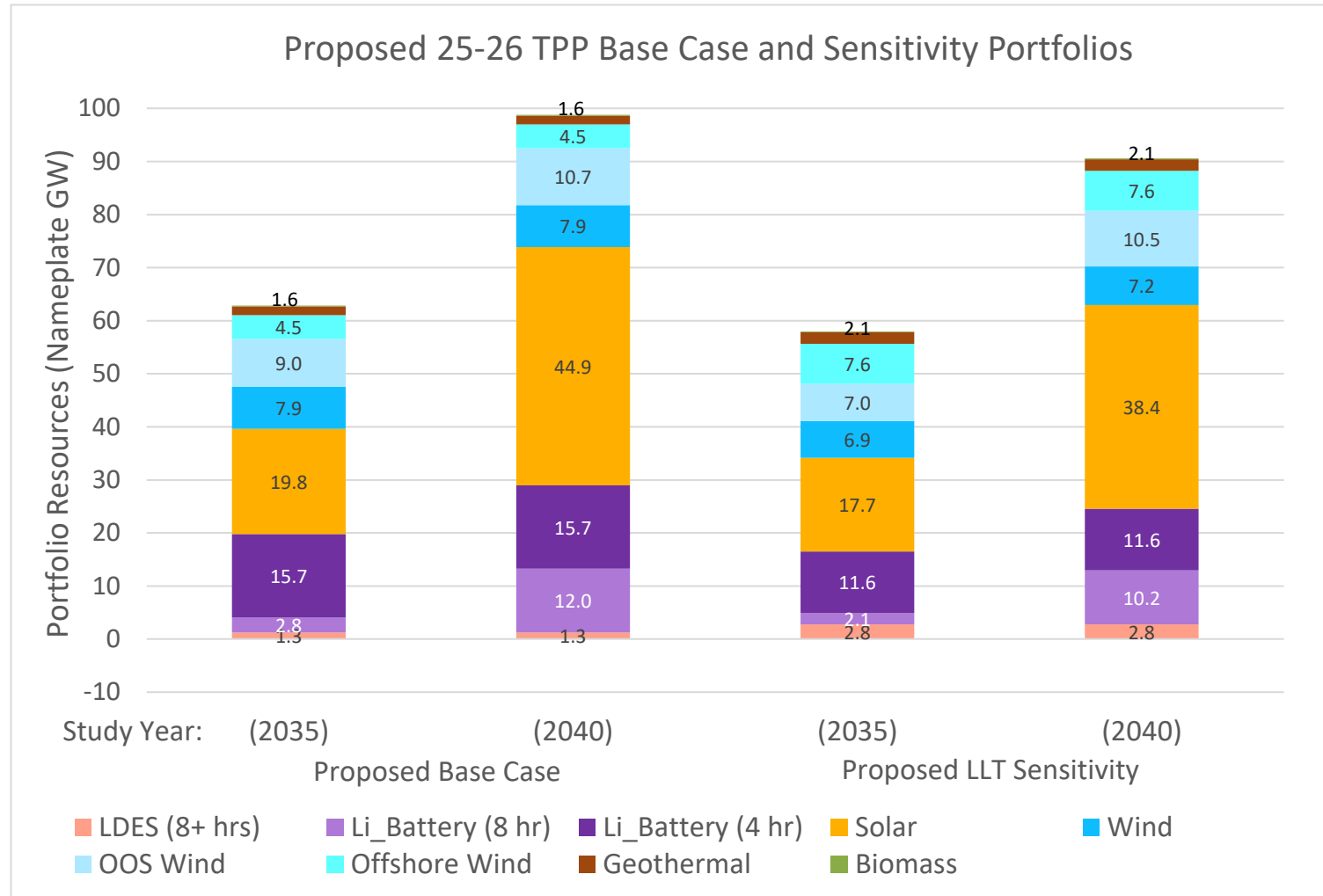
- Summary of initial mapping to the SCE Eastern and SDG&E areas
  - Includes comparison to 24-25 TPP and commercial interest.
- Key mapping issues working group continues to assess:
  - Land-use implications in SCE Eastern area for solar and SDG&E for wind
  - Commercial interest alignment for large amount of higher confidence storage and solar
  - Transmission exceedances in both areas
  - Mapping CAISO intertie locations for the 600 MW of Imperial area geothermal
  - 3 GW of New Mexico wind mapped to the Palo Verde intertie

Previous Base Case Comparison									
	Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)		Total Res (2035)	Total Res (2040)	24-25 TPP (2034)	24-25 TPP (2039)
<b>SCE Eastern</b>					<b>SDG&amp;E</b>				
Geothermal (MW)	500	500	790	790	Geothermal (MW)	100	100	160	160
Biomass (MW)	8	8	3	3	Biomass (MW)	-	-	-	-
OnshoreWind (MW)	325	325	324	324	OnshoreWind (MW)	1,816	1,816	1,564	1,564
OOS Wind (MW)	3,099	3,099	2,131	3,536	OOS Wind (MW)	-	-	-	-
Offshore Wind (MW)	-	-	-	-	Offshore Wind (MW)	-	-	-	-
Solar (MW)	4,274	7,554	3,459	5,834	Solar (MW)	1,515	3,785	1,583	1,920
Battery-4hr (MW)	3,969	3,969	2,680	2,680	Battery-4hr (MW)	1,697	1,697	1,390	1,390
Battery-8hr (MW)	120	1,035	270	1,070	Battery-8hr (MW)	125	1,190	100	305
LDES (MW)	-	-	-	-	LDES (MW)	409	409	437	487
<b>Zone Total (MW)</b>	<b>12,294</b>	<b>16,489</b>	<b>9,656</b>	<b>14,236</b>	<b>Zone Total (MW)</b>	<b>5,663</b>	<b>8,998</b>	<b>5,234</b>	<b>5,826</b>

Commercial Interest Comparison									
	Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest		Mapped Generic (2040)	TPD	Higher Confidence	All Queue Interest
<b>SCE Eastern</b>					<b>SDG&amp;E</b>				
Geothermal (MW)	500	-	-	671	Geothermal (MW)	100	-	-	83
Biomass (MW)	5	-	-	5	Biomass (MW)	-	-	-	-
OnshoreWind (MW)	268	-	60	761	OnshoreWind (MW)	1,816	300	1,923	3,223
OOS Wind (MW)	1,414	-	-	-	OOS Wind (MW)	-	-	-	-
Offshore Wind (MW)	-	-	-	-	Offshore Wind (MW)	-	-	-	-
Distrib. Solar (MW)	-	-	8	23	Distrib. Solar (MW)	14	-	4	22
Solar (MW)	4,080	500	9,994	20,785	Solar (MW)	2,697	485	4,773	13,073
Battery (MW)	1,086	4,736	15,069	33,381	Battery (MW)	1,337	2,386	9,557	25,002
LDES (MW)	-	500	1,917	1,917	LDES (MW)	409	-	-	500
<b>Total (MW)</b>	<b>7,352</b>	<b>5,736</b>	<b>27,048</b>	<b>57,542</b>	<b>Total (MW)</b>	<b>6,373</b>	<b>3,171</b>	<b>16,257</b>	<b>41,902</b>

# Mapping of the Proposed Sensitivity Portfolio

- Released mapping results are only for the base case portfolio
- Staff will also be working to map the proposed sensitivity portfolio, which includes additional offshore wind, geothermal, and long-duration storage resources.
  - Mapping is guided by base case mapping where resources align.
  - Same datasets and analysis will be applied.
  - Further analysis will be needed to identify additional locations for the additional long-duration energy storage and geothermal resources.



# Next Steps

- Busbar working group staff will continue to conduct mapping:
    - Use additional rounds of mapping to improve mapping alignment and incorporate additional data and feedback.
    - Conduct full mapping of the proposed sensitivity case.
  - Stakeholders will have the opportunity to provide written comments on the initial mapping results by 11/19/2024 in response to the Oct. 30<sup>th</sup> Ruling.
  - Go Vote!
- 
- Workshop slides will be available at the [Assumptions for the 2025-2026 TPP](#) webpage.
  - The workshop is being recorded; the recording and the workshop's Q&A will be posted online to the same webpage.

**Thank You!**